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Rogel et al.(10) **Pub. No.: US 2012/0116714 A1**(43) **Pub. Date: May 10, 2012**(54) **DIGITAL DATA PROCESSING SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER SOCIAL SPORTING ACTIVITIES**

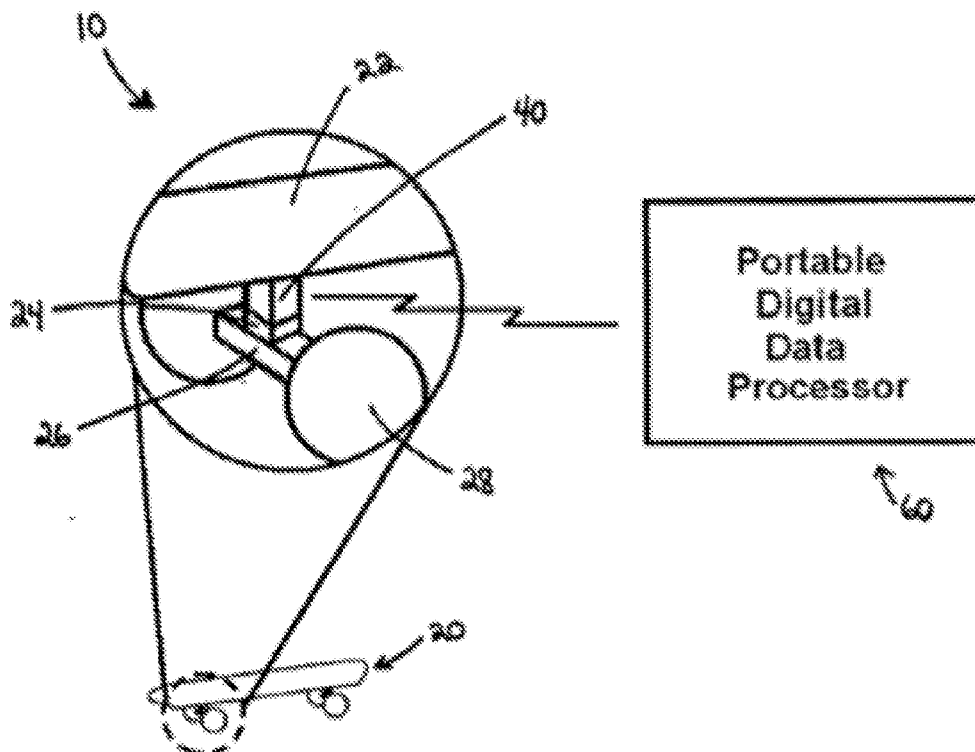
on Aug. 5, 2010, provisional application No. 61/386,207, filed on Sep. 24, 2010, provisional application No. 61/514,773, filed on Aug. 3, 2011, provisional application No. 61/514,752, filed on Aug. 3, 2011.

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(60) Provisional application No. 61/370,439, filed on Aug. 3, 2010, provisional application No. 61/371,161, filed

(57) **ABSTRACT**

Systems and methods for social and other sporting activities. A system according to one such aspect of the invention comprises a sensing device that is attached to an object, such as a skateboard (by way of non-limiting example), for measuring characteristics thereof. It communicates those characteristics wirelessly, e.g., via bluetooth, to a mobile device, such as a cell phone, personal digital assistant, or the like (by way of non-limiting example). That device can log and/or display those characteristics, graphically, for study or analysis by the operator (e.g., the skateboard enthusiast) or others.



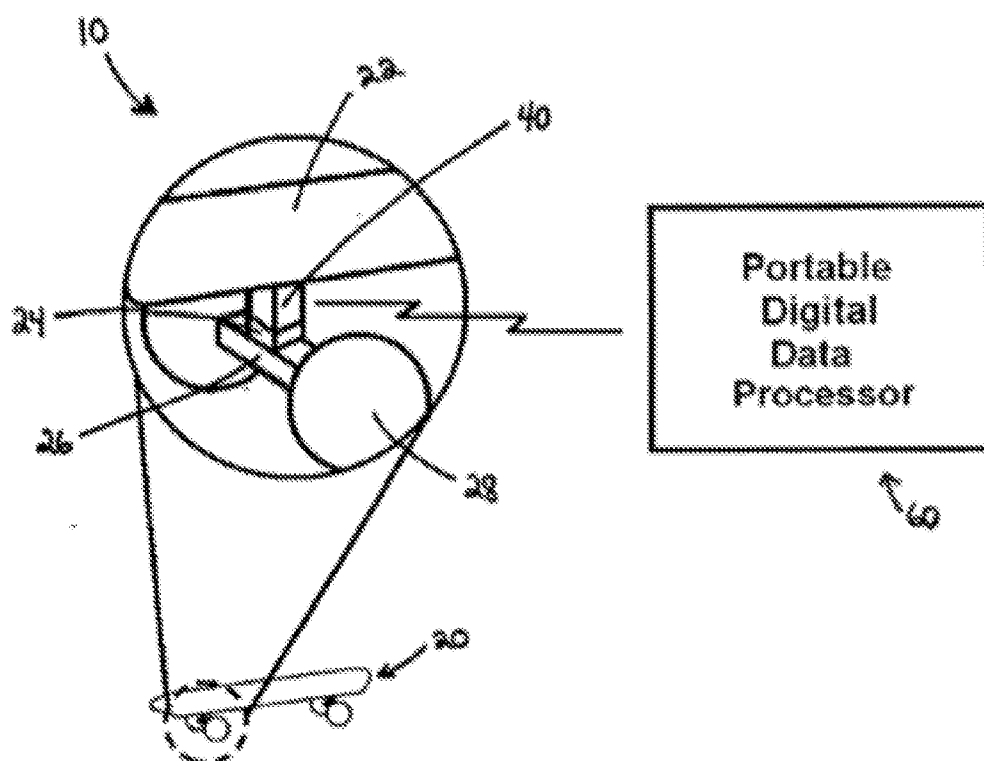


FIGURE 1

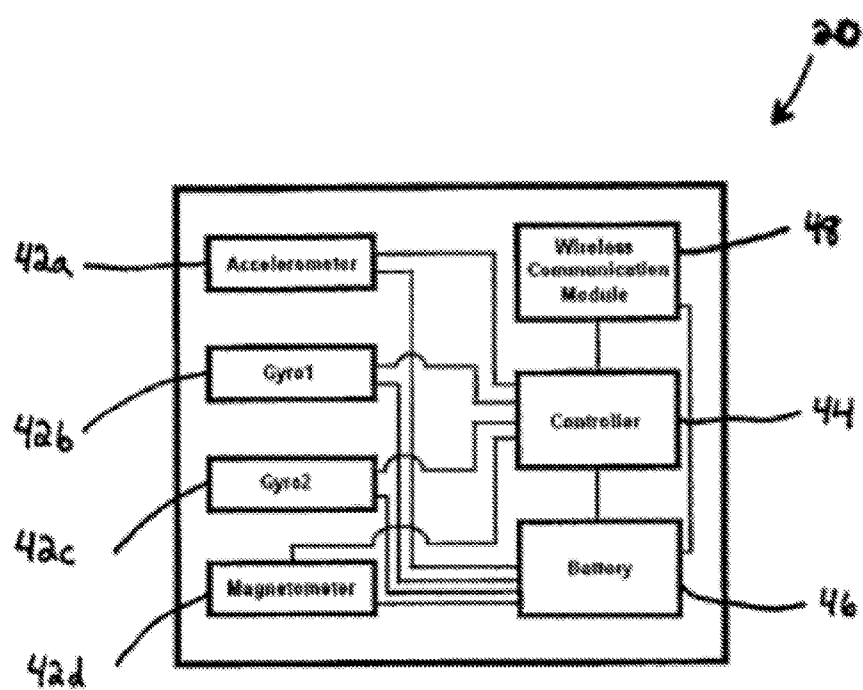


FIGURE 2

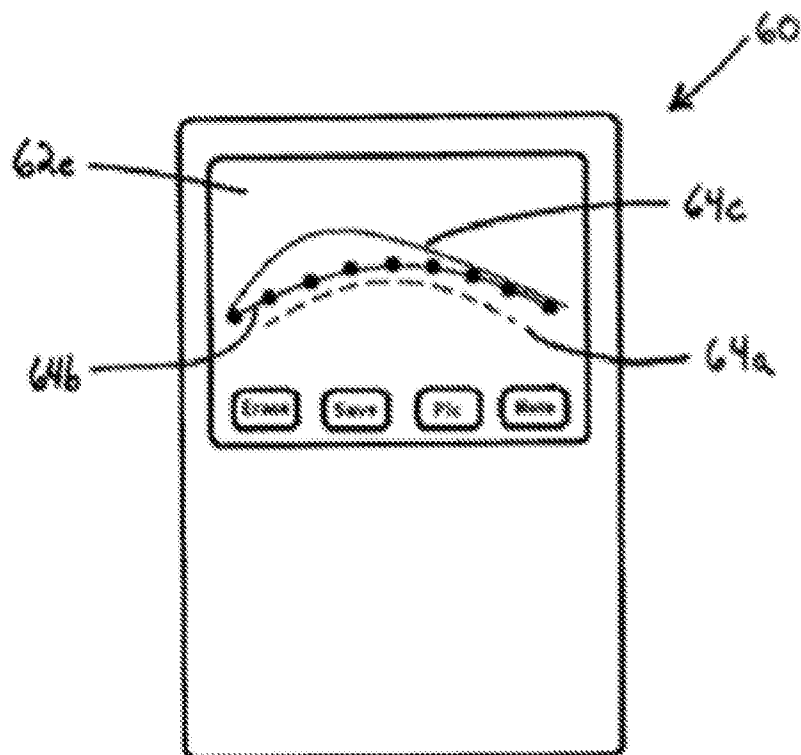


FIGURE 3A

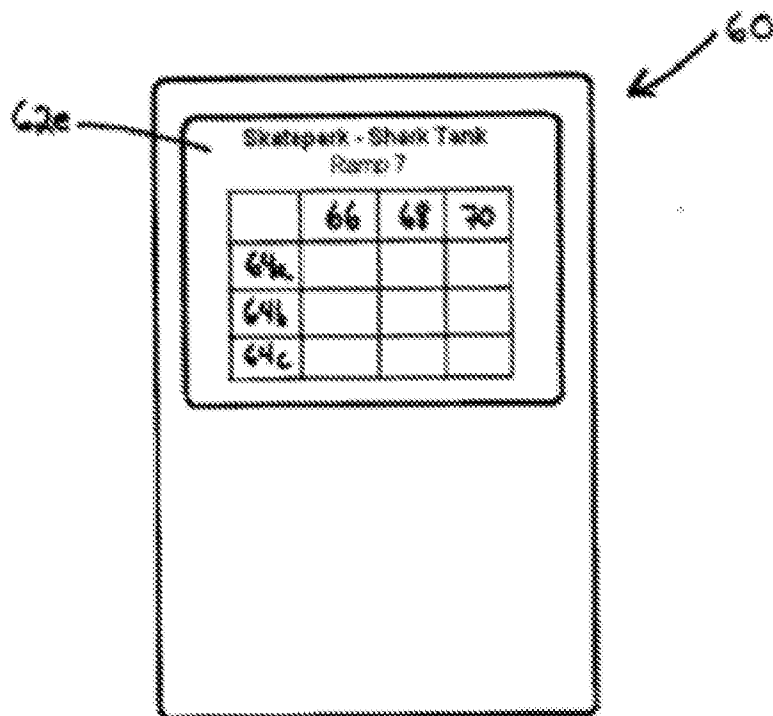


FIGURE 3B

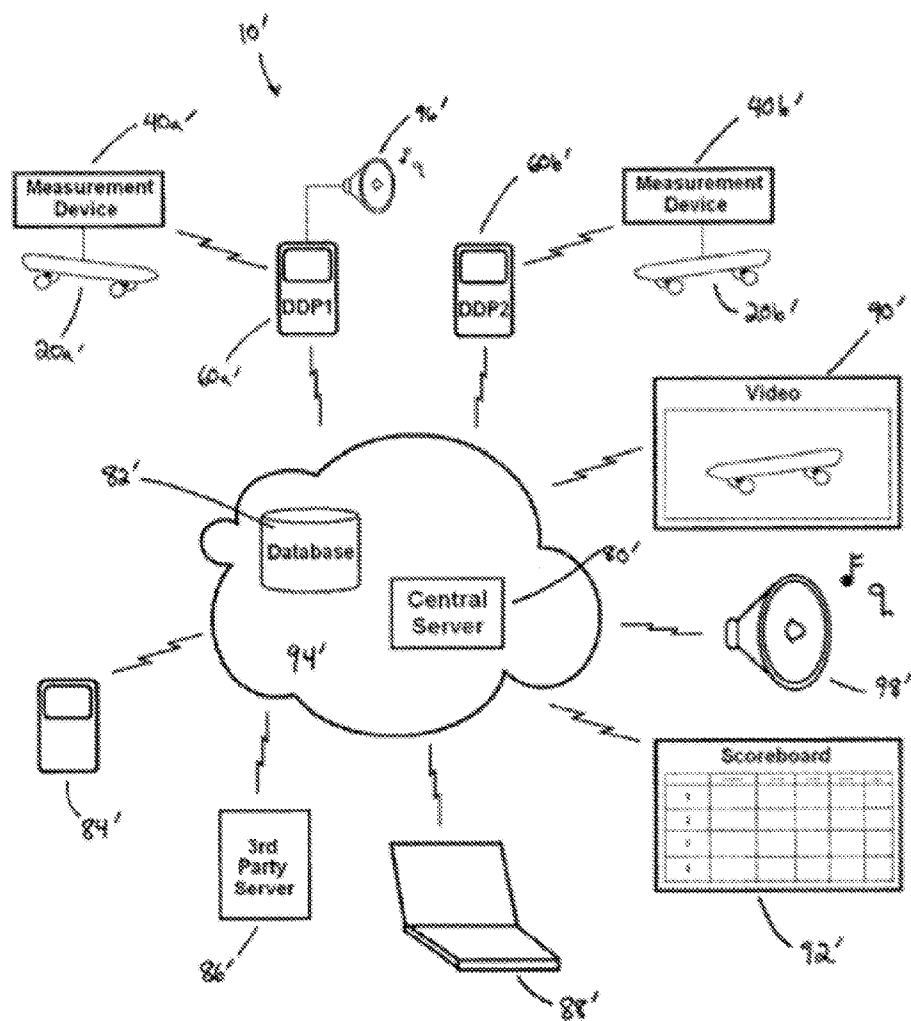


FIGURE 4

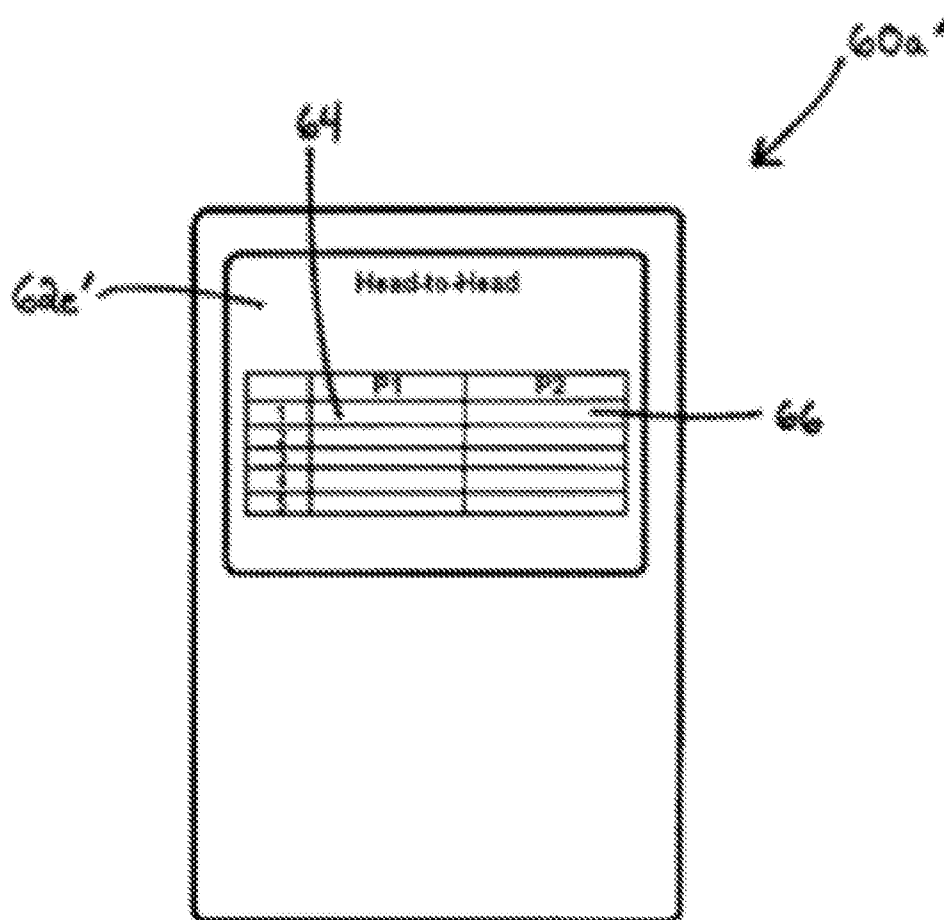


FIGURE 5

DIGITAL DATA PROCESSING SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER SOCIAL SPORTING ACTIVITIES

REFERENCE TO RELATED APPLICATIONS

[0001] This claims the benefit of filing of co-pending, commonly assigned U.S. Patent Application Ser. No. 61/370,439, filed Aug. 3, 2010, U.S. Patent Application Ser. No. 61/371,161, filed Aug. 5, 2010, and U.S. Patent Application Ser. No. 61/386,207, filed Sep. 24, 2010, all entitled “DIGITAL DATA PROCESSING SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER SOCIAL SPORTING ACTIVITIES,” the teachings of all of which are incorporated by reference herein.

[0002] This application is related to co-pending, commonly assigned U.S. patent application Ser. No. _____, filed this same day herewith, entitled “Devices, Systems, And Methods for Games, Sports, Entertainment And Other Activities Of Engagement,” the teachings of which are incorporated herein by reference.

[0003] This application is also related to co-pending, commonly assigned U.S. patent application Ser. No. _____, filed this same day herewith, entitled “Signature-Based Trick Determination Systems And Methods For Skateboarding And Other Activities Of Motion,” the teachings of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0004] The invention relates to sensing devices and systems for skateboarding and other social sporting activities. It has application in publicizing feats and facilitating competition among like-minded enthusiasts.

[0005] Skateboarders, as well as other social sporting enthusiasts, like to perform tricks using their skateboards. They practice the tricks over and over, either alone or in groups. They may perform these tricks in a skatepark, playground, or other spaces that have not been designed for skateboarding. They share their tricks, have similar musical interests, and are always in search of new places to try out their tricks. Moreover, skateboarders often buy their equipment from local skateboard shops. Skateboarders usually listen to music while they skate.

[0006] Social sporting enthusiasts can typically only display their feats to others in the same locale. For example, a skateboarder who has perfected a multiple varial heel flip, is usually limited to proving his/her prowess to friends at the local park. One of them might text or “tweet” news of the feat to others, but that is likely to be dismissed as unbelievable, particularly, if the feat is extraordinary. Some of that disbelief might be dispelled by posting of a video of the feat, but even that may be subject to skepticism.

[0007] An object of the invention is to provide improved sensing devices, improved systems and improved methods for skateboarding.

[0008] A related object is to provide such improved sensing devices, systems and methods as can be used in connection with other social sporting activities.

[0009] A related object is to provide such improved sensing devices, systems and methods as can be used in connection with other physical activities, regardless of whether social or sporting.

[0010] A further related object of the invention is to provide such improved sensing devices, systems and methods as can be used to publicize feats of skateboarders, other social sports enthusiasts and others.

[0011] A further related object of the invention is to provide such improved sensing devices, systems and methods as can be used to facilitate interaction and/or competition among remotely disposed skateboarders, other social sports enthusiasts and others.

SUMMARY OF THE INVENTION

[0012] The foregoing are among the objects attained by the invention, which provides in some aspects devices, systems and methods for social and other sporting activities. A system according to one such aspect of the invention comprises a sensing device that is attached to an object, such as a skateboard (by way of non-limiting example), for measuring characteristics thereof. It communicates those characteristics wirelessly, e.g., via bluetooth, to a mobile device, such as a cell phone, personal digital assistant, or the like (by way of non-limiting example). That device can log and/or display those characteristics, graphically, for study or analysis by the operator (e.g., the skateboard enthusiast) or others.

[0013] Related aspects of the invention provide a system, for example, as described above, in which the mobile device—in addition to or instead of logging and/or displaying the measured characteristics—transmits them to a server digital data processor, e.g., along with still images, video images, location and/or other information generated by the mobile device. The still/video images may be, for example, images generated by a camera on-board the mobile device. The location information may be, for example, GPS or other location data collected by that device. That other information may be identifying information specific to the mobile device, e.g., phone number, ESN, serial number, or so forth.

[0014] Further related aspects of the invention provide a system, for example, as described above, in which the server digital data processor logs the measured characteristics, along with still/video images, location information and/or other information, and makes them available for access by the aforementioned mobile device and/or by other data processing apparatus, such as, cell phones, personal digital assistants, portable computer, desktop computers, and so forth, of other enthusiasts—including other operators.

[0015] Still further related aspects of the invention provide a system, for example, as described above, in which the server digital data processor makes the measured characteristics, still/video images, location information and/or other information available for access via an addressable site on the Internet and/or via a social networking web site.

[0016] Yet still further aspects of the invention provide a system, for example, as described above, in which the server digital data processor, mobile devices, cell phones, personal digital assistants, portable computer, desktop computers and/or other data processing apparatus of the first aforesaid operator and/or of the other enthusiasts facilitate a challenge by one of those other enthusiasts, e.g., to surpass some or all of the measured characteristics of the first aforesaid operator, and/or vice versa—e.g., to engage in a competition.

[0017] Related aspects of the invention provide a system, for example, as described above, in which the mobile device of a competing enthusiast collects like information measured by a sensing device attached to an object, again, for example, a skateboard, operated by that enthusiast, and transmits that to

the server digital data processor, e.g., along with still images, video images, location and/or other information generated by that mobile device.

[0018] Still yet further related aspects of the invention provide a system, for example, as described above, in which the server digital data processor, mobile devices, cell phones, personal digital assistants, portable computer, desktop computers and/or other data processing apparatus of the first aforesaid operator and/or of the other enthusiasts initiate communications to operators when their measured characteristics have been exceeded by other enthusiast-operators.

[0019] Still yet further aspects of the invention provide a system, for example, as described above, in which the server digital data processor, mobile devices, cell phones, personal digital assistants, portable computer, desktop computers and/or other data processing apparatus of the first aforesaid operator and/or of the other enthusiasts facilitate a live competition among operators.

[0020] Still yet further aspects of the invention provide a system, for example, as described above, in which the server digital data processor, mobile devices, cell phones, personal digital assistants, portable computer, desktop computers and/or other data processing apparatus of the first aforesaid operator and/or of the other enthusiasts facilitate display the live competition to other enthusiasts, e.g., by webcast or otherwise.

[0021] Other aspects of the invention provide a system, for example, as described above, in which the sensing device includes a motion and/or other physical characteristic sensor (e.g., a sensor for speed, acceleration, jerk, yaw, pitch, roll, and so forth), as well as a bluetooth or other wireless transmitter.

[0022] Other aspects of the invention provide a system, for example, as described above, in which the mobile device includes (i) a bluetooth or other wireless receiver for receiving measured characteristics transmitted by the sensing device, and (ii) wifi, Edge, or other radio for transmitting measured characteristics, along with still/video images, location information and/or other information, to the server digital data processor.

[0023] Other aspects of the invention provide a system, as described above, for example, that generates an audio output based on the determined characteristic(s) of the object.

[0024] Related aspects of the invention provide a system, as described above, for example, in which the mobile device includes an audio output module capable of generating an audio output based on a prompt by the user and/or the data transmitted by the sensing device. In one aspect, the mobile device is capable of manipulating the audio output generated by the audio output device based on the data transmitted by the sensing device.

[0025] Other aspects of the invention provide a system, as described above, for example, which includes an audio output device remote from the mobile device.

[0026] Other aspects of the invention provide a system, for example, as described above, in which the mobile device executes applications software providing one or more of the functions that are attributed above to the mobile device.

[0027] Other aspects of the invention provide a system, as described above, for example, that generates an action to be performed by one or more objects, and determining if the actions were completed successfully. Related aspects allow a user to select the action to be performed or to prompt the mobile device to generate an action (which may be pre-

selected, randomly selected, or otherwise) to be performed. Related aspects allow the mobile device to determine a winner between users of two or more objects performing the actions. Related aspects include allowing users of the primary or a secondary mobile device to alert the primary mobile device that the actions were completed successfully.

[0028] Related aspects of the invention provide a sensing device as described above.

[0029] Related aspects of the invention provide a mobile as described above.

[0030] Related aspects of the invention provide a server digital data processor as described above.

[0031] Related aspects of the invention provide methods of operating one or more of the a sensing device, mobile device, and/or server digital data processor as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0032] A more complete understanding of the invention may be attained by reference to the drawings, in which:

[0033] FIG. 1 depicts a system according to the invention for generating, transmitting, and analyzing data related to the physical characteristic(s) of an object for use, e.g., in connection social and other sporting activities;

[0034] FIG. 2 schematically depicts a measurement device (a/k/a sensing device) according to the invention for generating and transmitting data for use in the system of FIG. 1;

[0035] FIGS. 3A-3B depict user interfaces of a system according to the invention for the display of information regarding a physical characteristic of the object of FIG. 1;

[0036] FIG. 4 depicts another embodiment of a system according to the invention for generating, transmitting, analyzing, and sharing data related to the physical characteristic(s) of an object;

[0037] FIG. 5 depicts an exemplary user interface for the display of information in the system of FIG. 4.

DETAILED DESCRIPTION OF THE ILLUSTRATED EMBODIMENT

Introduction

[0038] Despite the multitude of advanced technology found in the components of modern skateboards, there is very little technology dedicated to measuring the tricks that skateboarders perform. The old adage due to Lord Kelvin, “if you can’t measure it, you can’t improve it” applies to skateboarders. Systems according to the invention—hereinafter, referred to as “shuss”—comprise hardware and software that measures the feats (e.g., tricks) that skateboarders and enthusiasts of other sporting and non-sporting activities perform. For sake of convenience, and without loss of generality, the shuss system will be described in connection with skateboarding in much of the discussion below, though, it will be appreciated that it can be used in connection other sporting and non-sporting activities, as well.

[0039] As will be evident below, there are several uses of the shuss. It can be used to “score” or “rate” a particular trick. Unlike the prior art, where tricks are based on the opinion of judges, shuss provides an unbiased, objective measure. In addition, the trajectory and motion of the skateboard through space can be visualized, replayed, and compared any number of times on a computer or even a smartphone. This can be used to improve the skaters performance.

[0040] The shuss helps to engage a community of skaters with the extended shuss system. Using geolocation and a

database, it is possible for individuals to declare themselves “king of the park”. Yet another use of shuss is as a way of engaging a set of visitors to a festival. For example, contestants that can jump higher than a certain amount will win a T-shirt.

[0041] Skateboarders, as well as other social sporting activities, like to perform tricks using their skateboards. They practice the tricks over and over, either alone or in groups. They may perform these tricks in a skatepark, playground, or other spaces that have not been designed for skateboarding. They share their tricks, have similar musical interests, and are always in search of new places to try out their tricks. Moreover, skateboarders often buy their equipment from local skateboard shops. Skateboarders usually listen to music while they skate.

[0042] The invention leverages these different and unique characteristics of skateboarders. There are other groups that share these characteristics and so our invention is not limited to skateboarders. The invention involves hardware, mobile devices, and computer services, although we believe that not all components are necessary.

[0043] FIG. 1 depicts the shuss or other system 10 according to the invention for generating, transmitting, and analyzing data related to the physical characteristic(s) of an object for use, e.g., in connection social and other sporting activities. The illustrated system includes measurement device (a/k/a sensing device) 40 that is attached to a skateboard or other operator-enthusiast's object 20 and that is in wireless communications coupling with a mobile device (a/k/a portable digital data processor) 60.

[0044] The measurement device 40 measures motion and/or other physical characteristic of the object, e.g., speed, acceleration, jerk, yaw, pitch, roll, and so forth), and communicates those to the mobile device 60, which executes application or other software, firmware or the like, to log, analyze, and/or display that information.

[0045] Object

[0046] The object 20 of the illustrated embodiment is a skateboard. However, in other embodiments, it may be a surfboard, rollerblade boot, or other object having a characteristic that can be measured according to the teachings herein. The sensing device can be applied to measure or determine a wide variety of characteristics of such objects, the following list of which is intended to provide non-limiting examples of characteristics that can be measured and/or determined in accord with the teachings herein: position, velocity, acceleration, jerk, orientation, rotation, altitude, wind speed, temperature, vibration, etc. By way of non-limiting examples, the object (and an exemplary characteristic) can be, inter alia, a golf club (swing profile), a person diving off a springboard (rotation rate), or a dog on an agility course (path and speed through weave sticks).

[0047] The measurement device 40 can be coupled to any portion of the object 20. Preferably, the coupling is such that the measurement device 40 is protected from damage and maintains a given orientation relative to the object to provide accurate data regarding the characteristic(s) of interest. For example, because nearly the entire surface of the skateboard 20 depicted in FIG. 1 gets stepped on, grinded, or slammed against another object, the measurement device 40 can be coupled to or disposed within a riser or spacer 24 that is disposed between the deck 22 and one of the trucks 26 (which connects the wheels 28 to the deck 22). The measurement device 40 is preferably placed in the riser or spacer 24 such

that the deck 22 and the truck 26 protect the measurement device 40 from collisions. In some embodiments, more than one measurement device 40 can be coupled to the object to allow for additional data to be generated regarding the characteristic(s) of interest. For example, a skateboard 20 can have two measurement devices attached thereto, with each measurement device 40 coupled to one of the risers 24.

[0048] Measurement Device

[0049] The measurement device 40 coupled to the object 20 can have a variety of configurations according to the intended use of the measurement device 40 and the object 20 to which it is coupled. As shown in FIG. 2, the measurement device 40 generally contains one or more sensor(s) 42a-d, a controller 44, a wireless communication module 46, and a power source 48, although fewer, more, or different components can be included within the measurement device.

[0050] In a preferred embodiment as depicted in FIG. 2, the measurement device 20 is an Inertial Measurement Unit (IMU) chip. A person skilled in the art will appreciate that IMUs of the type commercially available in the marketplace, modified in accord with the teachings of herein, can be used to generate kinetic data. The IMU chip depicted in FIG. 2 contains four sensor(s) 42a-d, a controller 44, a power source 46, and a wireless communication module 48.

[0051] The sensors 42a-d can be configured to generate or obtain data about a characteristic of the object 20. The sensor (s) 42a-d can be any sensor known in the art or hereafter developed, modified in accord with the teachings of the invention, capable of generating data about a characteristic of the object 20. The sensors can be used alone or in combination according to the teachings of this invention, and it is within the skill of the ordinary artisan to select the particular sensor (s) to be included within the measurement device 20 depending on the data to be collected for a particular application, in light of the teachings herein. By way of example, the sensors 42a-d can obtain kinetic data that includes measurements about any one of, inter alia, the object's 20 location, orientation, velocity, acceleration, and rotation.

[0052] In a preferred embodiment, the sensor(s) 42a-d can be any of an accelerometer, a gyroscope, or a magnetometer. By way of non-limiting example, the measurement device 20 depicted in FIG. 2 includes each of an accelerometer 42a, a single-axis gyroscope 42b, a dual-axis gyroscope 42c, and a triple-axis magnetometer 42d. Generally, each of these components can be used to generate kinetic data about the object to which the measurement device 20 is attached. For example, the accelerometer 42a can generate data concerning the linear acceleration of the measurement device 40. In a preferred embodiment, the accelerometer 42a can generate data concerning the acceleration of the measurement device 20 along three orthogonal axes (i.e., along an x-, y-, and z-axis). The ADXL335 manufactured by Analog Devices of Norwood, Massachusetts is an example of a suitable three-dimensional accelerometer for use in accord with the teachings of the invention.

[0053] The single- and dual-axis gyroscopes 42b, 42c can generate data concerning the rotational motion of the measurement device 40. The LY530AL manufactured by STMicroelectronics of Geneva, Switzerland is an example of a suitable single-axis gyroscope for use in accord with the teachings of the invention. The LPR530AL manufactured by STMicroelectronics of Geneva, Switzerland is an example of a suitable dual-axis gyroscope for use in accord with the teachings of the invention.

[0054] The magnetometer 42d can generate data concerning the orientation of the measurement device 42. In a preferred embodiment, the magnetometer 42d is a triple-axis magnetometer that generates data concerning the three-dimensional orientation of the measurement device 40. The HMC5843 manufactured by Honeywell International, Inc. of Plymouth, Minn. is an example of a suitable triple-axis magnetometer for use in accord with the teachings of the invention.

[0055] As depicted in FIG. 2, the exemplary measurement device 40 includes a communication module 46 that enables the transfer of data generated by the sensors 42a-d to the portable digital data processor 60. Although the communication module 46 can be configured to allow for wired transmission of data (e.g. through a cable connection, USB device, flash-drive, or otherwise) between the measurement device 40 and the portable digital data processor 60, the measurement device 40 is preferably wirelessly connected to the portable digital data processor 60 via a wireless communication system arranged in known manners and utilizing known protocols to effect remote communication therebetween, modified in accord with the teachings herein.

[0056] In a preferred embodiment, the wireless communication module 46 is a Bluetooth SMD chip that enables remote communication with a receiver that is configured to receive a Bluetooth signal. As will be appreciated by a person skilled in the art, other wireless communication modules, either known in the art or developed hereafter and modified according to the teachings herein, can be used to establish wireless communication between the measurement device 40 and the portable digital data processor 60. By way of non-limiting example, the data may be transferred using WiFi, radio, infrared communication, or otherwise.

[0057] As depicted in FIG. 2, the exemplary measurement device 40 also includes a controller 44 that controls or configures the various components of the measurement device 40. The controller 44 can perform any number of functions, as will be appreciated by a person skilled in the art, depending on the particular application for which the measurement device 40 is used. By way of example, the controller 44 can configure the communication module 46 upon initially powering up or upon reset of the measurement device 40. The controller 44 can direct the communication module 46 to pair with a first-detected portable digital data processor 60. This first-detected portable digital data processor 60 can be recognized by the controller 44 as the primary portable digital data processor. The controller 44 can be configured to respond to commands given by the primary portable digital data processor to have the measurement device 40 perform any number of tasks such as, inter alia, powering off, entering sleep mode, gathering and/or transmitting data, controlling the transmission rate of data (e.g., 100 Hi) and/or pairing with additional portable digital data processors, as will be described in detail below.

[0058] The controller 44 can also process or control the processing of data. For example, the generated data can be processed locally to generate information related to a characteristic of the object or can be transmitted to the digital data processor 60 for analysis. For example, the controller 44 can compress the data generated by the components of the measurement device 40 (e.g., kinetic data generated by sensors 42a-d) and/or perform some initial analysis of the data to reduce the amount of data transmitted by the communication module 46. By way of non-limiting example, the controller 44 can determine if the data generated by the magnetometer 42d

appears faulty or distorted (as can occur when the magnetometer 42d is located in proximity to an object that alters the local magnetic field), and if so, prevent the transmission of this data. The controller 44 can also command the communication module 46 to transmit data only from selected sensors (e.g., only the three readings from the accelerometer 42a). As will be discussed in further detail below in regards to the processing of data which can be performed by the portable digital processor 60, the controller 44 can also be programmed to process the data generated by the sensors 42a-d to generate information about a characteristic of the device. For example, the controller can process the data substantially the same as, or even in place of the portable digital data processor 60. Alternatively, the controller can be configured to recognize, for example, the start of an action of interest such that the communication module 46 will not transmit data until the action is initiated. By way of example, the controller 44 can be configured to recognize an "Ollie" such that the communication module 46 only transmits data related to that particular trick.

[0059] As depicted in FIG. 2, the measurement device 40 can also include a power source 48. As will be appreciated by the skilled artisan, any of a variety of power sources modified in accord with the teachings herein can be used to provide power to the components of the measurement device 40. Preferably, the power source is rechargeable. For example, a LiPo battery can be integrated on the IMU chip. Though not shown, the measurement device 40 can include a socket into which a plug may be inserted to charge the power source 48. A cap can be used to cover the socket when the power source 48 is not being charged to keep out dirt and dust. Other methods of charging a power source 48 are known and can be adapted to work in concert with the teachings of this invention.

[0060] In order to extend the life of the power source 48, the measurement device 40 can be configured to enter sleep mode during non-use or inactivity. For example, the measurement device 40 can enter sleep mode if the communication module 46 is unable to connect to the portable digital data processor 60 for a pre-determined time (e.g., five minutes). Sleep mode can also be initiated, for example, by a prompt from a user (e.g., a command generated by the portable digital data processor 60 and transmitted to the measurement device 40 through the communication module 46) or by physically pressing a switch coupled to the measurement device 40. Additionally, the communication module 46 (e.g., a Bluetooth SMD chip) can default to operate in low-power mode such that the measurement device 40 conserves the power source. By way of example, a wireless communication module 46 operating in low-power mode can reduce the signal strength such that the portable digital data processor 60 must be within a given distance (e.g., 10 meters) of the measurement device 40 in order to communicate.

[0061] The measurement device 40 can be configured to exit sleep mode (i.e., activate) following a stimulus and/or prompt by the user. Because the communication module 46 typically consumes the most power, the measurement device 40 is preferably activated without the communication module 46 having to be on to detect the stimulus or prompt. By way of example, the measurement device 40 can be configured to activate when the accelerometer 42a generates an interrupt in response to movement of the measurement device 40 and the object 20 to which it is attached. The interrupt could be generated by the detection of any movement, or alternatively,

by a specific pattern of movement (e.g. three taps of the object 20 to which the measurement device 40 is coupled). Alternatively, the measurement device 40 can be activated by actuating a switch.

[0062] The measurement device 40 can also include an audio output device or module that generates an audio output (e.g., a song and/or sound or series of sounds), as will be discussed in detail below.

[0063] Portable Digital Data Processor

[0064] Again referring to FIG. 1, the system 10 also includes a portable digital data processor 60. As will be appreciated by a person skilled in the art, the portable digital data processor 60 can be any of a variety of commercially available processors or computers, modified in accord with the teachings herein, capable of receiving data from the measurement device 40 and capable of processing the data so as to generate information about a characteristic of the object 20 to which the measurement device 40 is attached. By way of non-limiting example, any of a computer, laptop, personal data assistant (PDA), or smart phone can be configured according to the teachings herein.

[0065] The portable digital data processor 60 can process the data about a characteristic of the object 20 to which the measurement device is attached. The portable digital data processor 60 can process the data, using known filters (e.g., high-pass, low-pass, and Kalman filters), formulas, and/or algorithms hereafter developed and modified according to the teachings herein, to generate information about a characteristic of the object (e.g., kinetic and/or spatial information) and/or assign that characteristic a rating (e.g., a tabulated score). For example, because a particular action can be defined by a sequence of transitions and overlaps between the values associated with different sensors 42a-d, the portable digital data processor 60 can identify the action (e.g., a specific trick) and assign a rating relative to a pre-determined standard.

[0066] As shown in FIG. 1, the portable digital data processor 60 can include one or more modules for the receiving, transmitting, processing, storage, generation and/or display of data and/or information about the characteristic(s) of the object 20. The portable digital data processor (e.g. mobile device) can also include an audio output device or module that generates an audio output (e.g., a song and/or a sound or series of sounds).

[0067] In an exemplary embodiment, the portable digital data processor 60 is a smart phone having a communication module capable of receiving the wireless communication signals generated by the measurement device 40. In this way, the smart phone can be held, for example, in a skateboarder's pocket within transmission range of the measurement device 40. Alternatively, the portable digital data processor 60 can be stationary relative to the object 40. For example, the portable digital data processor 60 can be a laptop computer that is positioned in proximity to a ramp or jump on which a characteristic of the skateboard will be determined. Alternatively, the measurement device 40 can generate and store the data such that the data can be transmitted to the portable digital data processor 60 when the measurement device 40 is brought within range of the portable digital data processor 60, or alternatively, upon a command generated by the portable digital data processor 60 for the measurement device 40 to transmit the data.

[0068] The data generated by the measurement device 40 and transmitted to the communication module of the portable

digital data processor 60 can be processed according to methods and algorithms known by those skilled in the art modified according to the teachings herein to obtain information about the object's 20 characteristic(s) of interest. The use of software, currently available or hereafter developed and modified in accord with the teachings herein, can be used to process the data generated by the measurement device 40.

[0069] For example, kinetic data generated by the sensor(s) 42a-d concerning the linear acceleration, rotational motion, and orientation of the measurement device 40 can be transmitted from the measurement device 40 to the portable digital data processor 60. The kinetic data received from the measurement device 40 can be processed by the portable digital data processor 60 to generate information about the object 20 to which the measurement device 40 is coupled. By way of non-limiting example, the portable digital data processor 60 can process the kinetic data to determine information relating to the motion, position, and/or orientation of the object 20 ("kinetic information").

[0070] In one embodiment, the portable digital data processor 60 can include a data generation module capable of generating data that can be used to generate additional information about a characteristic of the object 20 and/or the circumstances in which the characteristic was measured. By way of non-limiting example, the data generation module can be a location sensor that generates information about the physical location of the portable digital data processor 60. As will be appreciated by one of skill in the art, commercially available portable digital data processors can include a location sensor (e.g., GPS) that generates position data that can be processed according to the teachings herein. In this way, the portable digital data processor 60 can correlate the data received from the measurement device 40 and the data generated by the location sensor to generate a record containing information about the characteristic(s) of the object 20 and the location of the object 20 at which the characteristic was determined. By way of example, if the portable digital data processor 60 is carried in the pocket of a skateboarder, the location sensor of the portable digital data processor 60 can generate data that can be processed to associate the location of the skateboarder (e.g., a particular skate park and even a particular ramp/trick site) with the characteristic(s) of interest.

[0071] In one embodiment, the data generation module of the portable digital data processor 60 can help determine, for example, the airtime and height associated with a jump. By way of example, the portable digital data processor 60 can analyze the data of the data generation module capable of sensing vibrations caused by the object rolling over the ground, and the reduction in vibrations when the object is in the air) to determine characteristic information of height and airtime.

[0072] The portable digital data processor 60 can also include a multimedia capture module that allows the user of the portable digital data processor 60 to capture or generate multimedia content (e.g., text, images, video, and/or audio). As will be appreciated by one of skill in the art, commercially available portable digital data processors modified in accord with the teachings herein can include, inter alia, a keypad, a camera, or a microphone capable of generating multimedia content. Alternatively, the portable digital data processor 60 can acquire the multimedia content via a built-in or attached camera and/or via downloading from other devices/systems (e.g., web sites, networked computers, hard drives, memory

sticks, DVD/CDs, and so forth). In this way, the portable digital data processor 60 can generate a record which associates and/or references multimedia content with other data and/or information about the characteristic(s) of the object 20. By way of non-limiting example, the portable digital data processor 60 can associate the determined characteristic with any one of, inter alia, a picture of a skateboard ramp, a video of a jump, or a song that was played while performing a trick. The multimedia content can be associated with a particular record automatically or, for example, by a command from the user of the portable digital data processor 60. In this way, if a skateboarder performs a trick over a given ramp and the portable digital data processor 60 has generated kinetic information regarding this trick (i.e., a characteristic of interest), the portable digital data processor can capture multimedia (e.g., text regarding the jump or a picture of the ramp) and associate it with the characteristic of interest.

[0073] The portable digital data processor 60 can be configured to store the data, information, and/or record in a central store module which is based on database management, content management or other data storage technology known in the art, as adapted in accord with the teachings hereof. In this way, the user of the portable digital data processor 60 can access information related to a particular characteristic of interest and its associated content by referencing a particular record maintained within the central store.

[0074] In one embodiment, the portable digital data processor 60 includes an audio output module that generates audio output, e.g., a song selected by the user, a pre-recorded sound, a synthesized sound, or otherwise. This may be activated by the user and its volume, duration or other characteristics controlled by way of a switch (not shown) or otherwise. Alternatively, or in addition, the audio output can be a sound or series of sounds generated in response to the data received by the portable digital data processor 60 from the measurement device 40 regarding a characteristic of the object 20. For instance, as the object obtains a certain characteristic (e.g., a pre-determined speed, height, etc.), the portable digital data processor 60 can control the audio output device to generate a sound or series of sounds to alert the user as to the attainment of the characteristic(s). For example, while performing an “ollie,” the measurement device can generate data regarding the motion of the skateboard such that, for example, the audio output device generates a loud crashing noise when the skateboarder kicks down on the back edge of the skateboard. By way of another non-limiting example, the audio output device can generate a “whirling” sound when the object 20 is being spun. A user (e.g., skateboarder) can thus be alerted, for example, that the user has obtained a certain objective (e.g., reached a new personal best for the characteristic(s) of interest, successfully completed a trick, etc.).

[0075] In another exemplary embodiment, the audio output device can generate an audio output (e.g., a song with a given rhythm) that is manipulated based on the characteristic(s) of the object 20. By way of non-limiting example, the playback of the song can be sped up or slowed down in response to the speeding up or slowing down, respectively, of the object 20. An increase in height (e.g., a jump), for example, of the object 20 can amplify the high tones of the audio output, while a decrease in height (e.g., a landing) can amplify the low tones. Variations in the audio output can also prompt the user (e.g., skateboarder), for example, to perform a certain task (e.g., speed up) or alert the user to attempt a new action. In this way, the portable digital data processor 60 can be used as a learning

tool. In reference to a certain action desired to be performed by an object, for example, the audio output device can generate audio output (e.g., a signal) to alert the user to perform a sequence of actions, or perform the next in a sequence of actions, in order to attain the desired characteristic(s).

[0076] In addition to, or in the alternative to, outputting the audio output in real-time, the portable digital data processor 60' can associate an audio signal with a record. Subsequently accessing the record of a particular characteristic can access associated audio content such that the display and/or replay of the action of interest can provide the associated audio content.

[0077] In one embodiment, the portable digital data processor 60 can include a module that functions as a display interface 62e. The display interface 62e is configured to display information regarding a characteristic of the object and/or content associated therewith. The display interfaces 62e can include “widgets,” “wizards,” dedicated applications and other special-purpose programs that can be executed by users of the portable digital data processor 60. The display interface 62e can be integrated within the portable digital data processor 60 (e.g., an LCD screen on a smartphone), or alternatively, can comprise a separate display device in communication with the portable digital data processor 60. Operationally, the portable digital data processor 60 can process the data and/or information relating to the characteristic(s) of the object 20 to provide, for example, tables, graphs, scores, virtual images (or a series of images), video, plots, or other graphic or textual representations of the characteristic(s) of the object 20 to the display interface 62e. The display interface 62e can be configured to allow the user of the portable digital data processor 60 to interact with (e.g., view and manipulate) the display interface 62e and/or associate additional content or information with the record from which the display was derived.

[0078] Exemplary display interfaces are depicted in FIGS. 3A-3B. As shown in FIG. 3A, the display interface 62e is configured to display data and/or information generated by the measurement device 40 in accord with the teachings herein and one or more prompts 64 that allow the user of the portable digital data processor to manipulate the display (e.g., erase, save and/or associate the display with a record, associate the display with a note or picture). The display interface 62e depicts a graphical representation of the flight path of two “ollies” 66, 68 that were performed by a skateboarder using the methods and system 10 described above. That is, kinetic data related to the movement of the skateboard 20 with the measurement device 40 attached thereto can be generated and transmitted to the portable digital data processor 60. The kinetic data related to each of the “ollies” 64a, 64b can be analyzed by the digital data processor 60 to generate kinetic information related to the motion of the skateboard. The kinetic information can be further processed by the portable digital data processor to generate the kinetic interface display 62e. Although the graphical display interface 62e shown in FIG. 3A depicts a line plot of a particular characteristic (e.g., the representation of two “ollies” Ma, 64b showing a flight path, height, and distance of the object 20), one skilled in the art will appreciate that the data generated by the measurement device 40 can be manipulated according to known methods and processes, modified in accord with the teachings herein, to generate any variety of graphical displays.

[0079] The portable digital data processor 60 can be configured to access a database of “ideal” actions (e.g. by professionals) such that the user of the portable digital data processor 60 can compare the determined characteristic(s) to

a pre-determined standard. As shown in FIG. 3A, the portable digital data processor 60 displays an “ideal ollie” 64c, for example, one performed by a famous skateboarder such that user can visually compare the measured characteristics with that of another skateboarder. In this way, the system 10' can serve as an interactive teaching tool to help the user improve the characteristic(s) of interest.

[0080] For example, as shown in FIG. 3B, the display interface 62e can display the two measured “ollies” 64a, 64b and the “ideal ollie” 64c in table form. The display interface 62e can be populated with information from one or more records, for example, the identification of the object 20 (e.g., the user of the object 20), the characteristics of interest (e.g., height 66, distance 68, and a tabulated score 70) associated with the one or more records (e.g., ollies 64a', 64b', 64c'), and other associated information (e.g., the ramp on which the trick was performed, the date on which the trick was performed).

[0081] The display interface 62e can also be configured to display multimedia content associated with a record and/or, for example, a virtual representation of the object 20 during the action in which the characteristic is determined. Thus, the display interface 62e can display, for example, a photograph or video of the particular trick or motion being performed. Alternatively or in addition, the display interface can depict a virtual snapshot or video of the object 20 as it performs, for example, a particular motion or trick. As will be appreciated by the skilled artisan, the virtual representation of the kinetic information can be generated by the portable digital data processor 60 in accord with known methods and algorithms, adapted in view of the teachings herein.

[0082] By way of non-limiting example, software can be used to render a full virtual display of an object 20 in three-dimensions based on the data generated by the measurement device 40. The display interface 62e can be configured such that the virtual display of the object 20 can be repositioned in virtual space (e.g. rotated) by user interaction. In one embodiment, the user of the primary digital data processor 60 can control the frame rate and virtual camera angle of the virtual display of the object 20 such that the user can view the object 20 as it performed a particular action to see, for example, how the object 20 moved over time. Panda—3D, an open source three-dimensional game engine is an example of suitable software for use in accord with the teachings herein. Further, if the physical location at which the action was performed is known, software could be used to model the physical space such that the virtual display of the can be overlaid in a virtual space representative of the physical space.

[0083] of the trick is known, it is possible to model the physical space as well so that the virtual board can be seen moving in the virtual world in a way that exactly mirrors how the real skateboard moved through the real world. It is possible to overlay two or more iterations of the trick to make it easy to see variation. Such information is useful to knowing what was done wrong.

[0084] System 10'

[0085] FIG. 4 depicts a system 10' according to another exemplary embodiment of the invention. FIG. 4 and the discussion below are intended to overview an example of the architecture with which the invention is practiced, other configurations of which fall within the scope thereof. The system 10' of FIG. 4 is similar to the system 10 depicted in FIGS. 1-2 in that the system 10' includes a primary measurement device 40a' coupled to a primary object 20a' and in communication with a primary digital data processor 60a'. The system 10' can

additionally include a central store 82' and/or one or more nodes 84'-92' in communication with the primary digital data processor 10' through a central server 80'. The central server 80' can be in communication with the central store 82' and the one or more nodes 84'-92' via a network 94'. The system 10' can allow for the transmission and exchange of content between any of the primary digital data processor 10', the central store 82', the nodes 84'-92', and any other device modified in accord with the teachings herein which can communicate with the system 10'. For example, the system 10' can include a secondary measurement device 40b' coupled to a secondary object 20b' and in communication with a secondary digital data processor 60b'. System 10' can also include an audio output device, as discussed above, associated with one or more of the nodes 84'-92'. Alternatively, or in addition, the system 10' can include a dedicated audio output device 96'.

[0086] As discussed above in reference to system 10, the content handled by the system 10' can include data generated by the primary and/or secondary measurement device 40a', 40b', information about a characteristic of the primary and/or secondary object 20a', associated information (e.g., identification of the primary object 20a' or its user, information about the circumstances under which the characteristic was determined such as the location and date), and multimedia content such as images, video, and audio data. The system 10' can also be configured to handle content such as text data, notifications, advertisements, events, and other information that can be distributed to the primary and secondary portable digital data processors 60a', 60b' and any of the other nodes 84'-92'.

[0087] As discussed above in reference to the digital data processor 60 of FIGS. 1 and 2, the primary digital data processor 60a' can generate information about a characteristic of an object 20a' from data generated by a measurement device 40a' coupled to that object 20a'. Alternatively, in one embodiment, the data generated by the primary measurement device 20a' and/or the primary processor 60a' can be processed locally or transmitted to the central server 80' for analysis. The primary digital data processor 60a' can be configured to communicate data and/or information about a characteristic of the object 20a' or other content with the secondary portable digital data processor 60b' and the nodes 84'-92' directly and/or through the server 80'. Information can be acquired by the nodes 84'-92' in various ways as will be appreciated by a person skilled in the art. Thus, by way of non-limiting example, (a) the primary digital data processor 60a' can acquire kinetic data regarding the motion and orientation of the object 20a'; (b) process that data to generate kinetic information about the movement of the object 20a'; (c) display the kinetic information in the form of a kinetic display (e.g., in the form of graphs, tables, scores, a virtual representation or video) on a display module of the primary digital data processor 60a'; (d) associate the kinetic information with multimedia content (e.g., an image, video, or audio clip); and/or (e) transmit the kinetic data, kinetic information, kinetic display, and/or multimedia content to the secondary digital data processor and/or nodes 84'-92' directly and/or through a central server 80'.

[0088] As depicted in FIG. 4, the secondary portable digital data processor 60b' can also be in communication with a second measurement device 40b' that is attached to a secondary object 20b'. The secondary portable digital data processor 60b' can be configured substantially the same as the primary portable digital data processor 60a'. That is, the secondary digital data processor 60b' can receive the data generated by

the secondary measurement device **40b'**, process the data to obtain information about the secondary object's **20b'** characteristic(s) of interest, display the information, and/or transmit the information to the server **80'**. Additionally, the primary and secondary portable digital data processors **60a'**, **60b'** can be configured to be in communication with one another such that information regarding the characteristic(s) of their respective objects **20a'**, **20b'** can be shared directly between the portable digital data processors **60a'**, **60b'**.

[0089] The secondary portable digital data processor **60b'** can also be configured to communicate with the primary measurement device **20a'**. That is, the secondary portable digital data processor **60b'** can receive the data generated by the primary measurement device **20a'**, process the data to obtain information about the primary object's **20a'** characteristic(s) of interest, and display the information, as discussed in detail above. The secondary portable digital data processor **60b'** can be configured, for example, to automatically communicate with the primary measurement device **20a'**, or can communicate with the primary measurement device **20a'** only upon being granted permission by the primary portable digital data processor **60a'**. In this way, the primary and secondary portable digital data processors **60a'**, **60b'** can each transmit and/or receive information regarding the object's **20a'** characteristic(s) of interest, as well as any associated content, and process that information as discussed herein. Similarly, the primary portable digital data processor **60a'** can be configured to communicate with the secondary measurement device **20b'**.

[0090] Additionally, as will be appreciated by one of ordinary skill in the art, both the primary portable digital data processor **60a'** and the secondary portable digital data processor **60b'** can be considered nodes (as otherwise used herein) in that the portable digital data processors **60a'**, **60b'** can also be configured to communicate with the server **80'**.

[0091] The illustrated server **80'** can aggregate, process, and/or serve data and/or information generated by one or more measurement devices **20a'**, **20b'** and processed by one or more digital data processors **60a'**, **60b'** to and/or from one or more of the nodes **84'-92'**. Although the nodes **84'-92'** are depicted as connected to a single server **80'**, it will be appreciated that the invention can be practiced with fewer or more servers, as well as without any servers. The server **80'** can comprise one or more personal computers, workstations, or other digital data processing devices of the type commercially available in the marketplace as adapted in accord with the teachings herein. A plurality of servers **80'** can be coupled for communications with one another over a network **94'**, may be collocated, distributed or otherwise.

[0092] The server **80'** can also process the information and associated content, e.g., for transmission to the nodes **84'-92'**. This can include generating thumbnails and/or optimized versions of the records for display or other presentation on the nodes. The server **80'** can also aggregate a record with supplementary information provided by a transmitting node (e.g., the primary portable digital data processor **60a'**) or from other nodes **84'-92'**. Supplementary information can include, by way of non-limiting example, comments from the users of one of nodes **84'-92'**, additional multimedia submitted by the users of nodes **84'-92'**, and/or communication or queries from the users of nodes **84'-92'**. Processing by the server **80'** can further include tagging the records, for example, in accord with the supplementary information and/or in accord with designations made by a node user. In some embodiments,

tagging can also be based on record content (as determined, for example, by the location at which the characteristic was determined). In the embodiment illustrated in FIG. 4B, tagging allows categorization of the records into sets defined by one or more of the node users.

[0093] The server **80'** can store the aforementioned record and other associated information in a central store **82'** (e.g., database) based on database management, content management or other data storage technology known in the art, as adapted in accord with the teachings hereof. The central store **82'** can contain one or more records and/or other database structures storing or otherwise reflecting, for each record its related information—e.g., the user, information about the characteristic, the location at which the characteristic was determined, multimedia content associated with the record, etc. By way of example, the central store **82'** depicted in FIG. 4 can store information in each record related to the skater, identification of a trick, the location at which the trick was performed, the height of the object trick, average speed, number of rotations, a tabulated score, and any of an associated image, video, and/or comments. In other embodiments, other information may be contained in the central store **82'**, instead or in addition.

[0094] Network **94'** can provide communications coupling between the server **80'**, the portable digital data processors **60a'**, **60b'**, and/or the nodes **84'-92'**. The network **94'** can include one or more cellular networks, one or more Internets, metropolitan area networks (MANs), wide area networks (WANs), local area networks, personal area networks (PANs) and other networks, wired, wireless, terrestrially-based, satellite-based, or otherwise, known in the art suitable for transport of digital content, data and commands in accord with the teachings hereof.

[0095] Generally, the nodes **84'-92'** comprise electronic devices or systems that (i) can communicate with the primary digital data processor **60a'**, (ii) can communicate with one another and/or with the server **80'**, and/or (iii) display, acquire, and/or provide information regarding the characteristic(s) of the primary object **20a'** and/or one or more other secondary objects **20b'** and/or additional content. The nodes **84'-92'** comprise, by way of non-limiting example, smart phones, mobile phones, personal digital assistants (PDAs), personal computers, real-time displays, third-party servers or server systems, all of the type commercially available in the marketplace as adapted in accord with the teachings herein. It will be appreciated that while individual examples of such electronic devices are shown in the illustrated embodiment, other embodiments can incorporate less, more, or different devices. Although the particular nodes are depicted as a smartphone **84'**, a third-party server **86'**, a computer **88'**, a multimedia content display **90'**, and a real-time display **92'**, it will be appreciated that other devices may be used in practice of the invention described herein, instead of or in addition to those shown in FIG. 4. It should be further appreciated that the methods of operation and/or manners of interaction discussed below in connection with FIG. 4 may apply to other devices and/or configurations as well. For example, although two portable digital data processors **60a'**, **60b'** and a plurality of nodes **84'-92'** are shown in the drawing, it will be appreciated that the invention can be practiced with more or fewer digital data processors in communication with more or fewer measurement devices, and more or fewer nodes which can also function as digital data processors.

[0096] Each of the nodes 84'-92' can include a display interface as discussed above in reference to the display interface 62e of the portable digital data processor 60 of FIGS. 1 and 2. As will be appreciated by the skilled artisan, the display interface of nodes 84'-92' can be configured to be an interactive interface and can display information about the characteristic(s) of interest and/or associated information and content. The interfaces can also depict the information and content on-demand, and can allow the users of the portable digital data processor 60a', 60b' or the nodes 84'-92', for example, to display information, content, and/or records received from the central server 80'. Indeed, by way of non-limiting example, one or more of the nodes 84'-92' can be dedicated display interfaces.

[0097] The nodes 84'-92' can be configured to acquire record information and/or provide content. By way of example, the users of nodes 84'-92' can associate supplementary information (e.g., comments, pictures, video, etc.) with a record generated by the user of the primary digital data processor 60a'. Access to records generated by other nodes 84'-92' can be a function of permissions and preferences. Particularly, server 80' can transmit to (or otherwise permit display on) the nodes 84'-92' only those records to which the particular node has permission (e.g., by way of hardware and/or user authentication). Such permissions may be granted, for example, by default, as a consequence of payment of a service fee, activation of a user account, action of a node user, e.g., via a user interface of the type described herein, action of an administrator, e.g., using a web site or other interface to the server 80', and so forth.

[0098] Records received by the nodes 84'-92' from server 80' may be presented to the respective users of those nodes, for example, depending on display preferences set for those devices 84'-92', e.g., by default, user action or otherwise. Thus, for example, the node 92' (the "real-time display") can be configured to present the records in tabular form while another node 90' (the "multimedia display") can be configured to display multimedia content associated with the records. For example, if one or more measurement devices were being used at a skateboarding competition, the multimedia display 90' can be configured to display images, video, and/or virtual representations of the skateboard and skateboarders performing tricks, and the real-time display 92' can be configured to display the results of the competition, as determined by a data processor analyzing the data generated by one or more measurement devices coupled to the competitors' boards.

[0099] As discussed above with reference to the system of FIGS. 1-2, one or more of the nodes 84'-92' and/or one or more of the portable digital data processors 60a', 60b' can include an audio output device. As shown in FIG. 4, the primary digital data processor 60a' includes a primary audio output device 96' coupled thereto. As will be appreciated by the person of ordinary skill in the art, the primary audio output device 96' can be integrated within the primary portable digital data processor 60a' in accord with the teachings herein and/or can be an external module (e.g. a speaker) physically or wirelessly coupled to the primary portable digital data processor 60a'. The primary digital data processor 60a' can control the primary audio output device 96' to generate audio output and/or manipulate the audio output in response to the determined characteristic(s) of the primary object 20a', as discussed above.

[0100] The system 10' can also include one or more secondary audio output devices 98' associated therewith. As shown in FIG. 4, the secondary audio output device 98' can be a dedicated audio output device (e.g., a speaker) that can generate audio output in response to the characteristic(s) of interest transmitted through the central server 80'. One or more secondary audio output devices can also be associated with the nodes 84'-92'. Though not shown, an audio output device can be associated with the multimedia display 90', for example, such that the multimedia display 90' can display images (e.g., the action of the primary object 20a') as well as audio. The audio can be generated and/or manipulated, for example, by the action of a user and/or based on the determined characteristic(s) of the object, as discussed above. In this way, the characteristic(s) of the object can be associated with a sound and/or song such that displaying of a photo, video, and/or virtual representation of the object 20a' performing the action can also "display" the associated audio output. Thus, a producer of a movie, for example, need not manually overlay particular music given action in the movie. Rather, the action of the object itself can control the associated audio output.

[0101] The third-party server 86' can allow users to access information regarding the characteristic(s) of one or more objects 20a', 20b' and other associated information and/or content. The third-party server 86' can comprise, for example, a website and/or other repository of information. The third-party server 86' can communicate with the server 80', transmit information about a characteristic of one or more object 20a', 20b', provide images and other multimedia content to the central server 80' automatically (on action of the third-party server 86'), at the request of the server 80', and/or at the request or behest of a user of the third-party server 86'.

[0102] Communication between the nodes 84'-92' and the one or more portable digital data processors 60a', 60b' enables a variety of competitions and interaction between the users of the system 10'. By way of example, FIG. 5 depicts the user interface 62e' for an exemplary competition between two or more users of the system 10'; an explanation of which will aid in an understanding of the operation of the systems and methods described herein.

[0103] The user of a first portable digital data processor 60a' can communicate to the central server 80' an invitation to other users in the system 10' to a competition. The invitation can be targeted to a specific user, or can be communicated generally to any user. The user of a second digital data processor 60b' can be alerted by the central server 80' via e-mail, text, or otherwise as described herein, and can communicate his acceptance through the central server 80'. Accordingly, the user of the first portable digital data processor 60a' and the user of a second digital data processor 60b' can initiate a competition. Other users of the system 10' (e.g., node 84') can observe the competition as a spectator through the central server 80'.

[0104] As depicted in FIG. 5, each of the portable digital data processors 60a', 60b' can generate a display interface 62e' displaying actions to be performed and the associated characteristic(s) of interest. The user of the primary portable digital data processors 60a' can then perform the listed actions, in proximity or remote to the other user, such that the measurement device 40a' coupled to the object 20a' generates data regarding the characteristic(s) of interest. The primary digital data processor 60a' can receive the data generated by the primary measurement device 40a' and process the data

locally (or alternatively transmit the data to the central server **80'** for processing). Processing of the data can generate information about the characteristic(s) of interest of the primary object **20a'** (e.g. height and speed) and can calculate a rating **64** (e.g., score) for the characteristic(s) of interest. The central server **80'** can be configured to receive the information from the primary digital data processor **60a'** and can be configured to transmit the information to the secondary digital data processor **60b'** for display on the display interface of the secondary digital data processor **60b'**.

[0105] Similarly, the user of the secondary digital data processor **60b'** can perform the listed actions such that measurement device **40b'** generates data regarding the characteristic(s) of interest. The secondary digital data processor **60b'** can receive the data generated by the secondary measurement device **40b'** and can process the data locally (or alternatively transmit the data to the central server **80'** for processing). Processing of the data can generate information about the characteristic(s) of interest of the secondary object **20b'** (e.g. height and speed) and can calculate a rating **66** (e.g., score) for the characteristic(s) of interest. The central server **80'** can be configured to receive the information from the secondary digital data processor **60b'** and can be configured to transmit the information to the primary digital data processor **60a'** for display on the display interface of the primary digital data processor **60a'**. After the list of actions has been performed, a winner can be determined, for example, according to the highest total score.

[0106] In one embodiment, the primary digital data processor **60a'** and display interface **62e'** can be configured to allow for the playing of a single- or multi-player game. The display interface **62e'** be a part of a "widget," "wizard," dedicated application or other special-purpose program that can be executed by a user of the portable digital data processor **60a'**. Operationally, the primary portable digital data processor **60a'** can process the data and/or information relating to the characteristic(s) of the objects **20a'**, **20b'** to provide, for example, tables, graphs, scores, virtual images (or a series of images), video, plots, or other graphic or textual representations of the characteristic(s) of the object **20a'**, **20b'** to the display interface **62e'**. The display interface **62e'** can be configured to allow the user of the portable digital data processor **60a'** to interact with (e.g., view, manipulate, control) the display interface **62e'**.

[0107] In a single player format, for example, the user of the primary digital data processor **60a'** can prompt the display interface **62e'** to generate a trick or a sequence of tricks to be performed by the user of the primary object **20a'**. The trick or sequence of tricks can be, for example, selected by the user, inputted by the user, or generated by the primary digital data processor **60a'** or display interface **62e'** based on an input from the user (e.g., by shaking the primary portable digital device **60a'** to have the display interface **62e'** display a new trick to be performed). The primary digital data processor **60a'** can command the primary measurement device **40a'** to monitor for this particular trick or sequence of tricks. As discussed above, the primary digital data processor **60a'** can determine by way of the data generated by the measurement device **40a'** if the trick or sequence of tricks were successfully completed. Alternatively, or in addition, the primary digital data processor **60a'** can receive information regarding the successful completion of the trick through the display interface **62e'** by way of input from the user of the primary digital data processor **60a'** (e.g., by the trick's performer or an

observer). Alternatively, the primary digital data processor **60a'** can receive information regarding the successful completion of the trick by way of input from a user without receiving, generating, and/or processing data from the measurement device **40a'**. In one embodiment, the primary digital data processor **60a'** can receive input regarding the successful completion of the trick by way of input of a third-party user of a secondary digital data processor **60b'** connected (e.g., directly, wirelessly, through the central server **80'**, or otherwise) to the primary digital data processor **60a'**. The results (e.g., the successful or unsuccessful completion and characteristic(s) related to the action of interest) can be displayed on the user interface **62e'** as discussed herein.

[0108] In a multi-player format, for example, the primary digital data processor **60a'** can also be in wireless communication with a second measurement device **40b'** that is attached to a secondary object **20b'**. The primary digital data processor **60a'** can thus receive data generated by both the primary and secondary measurement devices **40a'**, **40b'**, process the data to obtain information about the primary and secondary object's **20a'**, **20b'** characteristic(s) of interest, display, and/or compare the information. By way of example, the primary digital data processor **60a'** can prompt the display interface **62e'** to generate a trick or a sequence of tricks to be performed by the users of the object **20a'**, **20b'**. As discussed herein, the users of the objects **20a'**, **20b'** can then attempt to perform the listed actions, such that the measurement devices **40a'**, **40b'** generate data regarding the characteristic(s)/action(s) of interest. The primary digital data processor **60a'** can receive the data generated by the primary and secondary measurement devices **40a'**, **40b'** for the tricks or sequence of tricks and process the data locally (or alternatively transmit the data to the central server **80'** for processing). Processing of the data can generate information about the characteristic(s) of interest of the objects **20a'**, **20b'** (e.g. successful completion of a trick, height, speed) and/or can calculate a rating (e.g., score) for each trick that can be displayed on the display interface **62e'** of the primary digital data processor **60a'**, as depicted in FIG. 5. As discussed above, the primary digital data processor **60a'** can receive information regarding the successful completion of the trick by way of input from a user of the primary digital data processor **60a'** or from a third-party user of a secondary digital data processor. The results (e.g., the successful or unsuccessful completion and characteristic(s) related to the action of interest) can be displayed on the user interface **62e'** as discussed herein and as depicted in FIG. 5, for example. After the list of actions has been performed, a winner can be determined, for example, according to the highest total score or the successful completion of the most tricks.

[0109] In an alternative embodiment, the user of a secondary portable digital data processor **60b'** can access previous records from the central server **80'**. The user of the secondary portable digital data processor can send the owner of the object which generated a particular record a notification alerting the owner that the user of the secondary portable digital data processor **60b'** will attempt to surpass the characteristic associated with the particular record. Performing the steps described herein for generating, processing, and transmitting data, the secondary digital data processor **60b'** can determine the characteristic(s) of interest and transmit the information to the central server **80'**. Accordingly, users of the system **10'** can serially attempt to best the characteristic(s) of interest.

[0110] A further understanding of the invention can be attained with reference to the appendix attached hereto. An appreciation of embodiments of the invention may be attained by reference to incorporated-by-reference, co-pending, commonly assigned U.S. patent application Ser. No. _____, filed this same day herewith, entitled “Devices, Systems, And Methods for Games, Sports, Entertainment And Other Activities Of Engagement,” as well as to incorporated-by-reference, co-pending, commonly assigned U.S. patent application Ser. No. _____, filed this same day herewith, entitled “Digital Data Processing Systems And Methods For Skateboarding And Other Activities Of Motion,” the teachings of both which are incorporated herein by reference and copies of both of which are attached as an appendix hereto.

[0111] Described above are methods and system meeting the objects and goals set therefor. Those skilled in the art will appreciate that the embodiments shown in the drawings and

described in the accompanying text are merely examples and that other embodiments, incorporating modifications and changes therein and including combinations of foregoing embodiments, fall within the scope of the invention.

[0112] Thus, by way of non-limiting example, it will be appreciated that the steps depicted in the figures may be performed in any suitable order, the ordinal numbering of those steps therein notwithstanding, as it is provided only for explicative purposes. The use of known data processing techniques, known hardware configurations, and known programming constructs, including web-related programming, known data storage or database principles, are contemplated herein to effect the novel methods and systems disclosed herein. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed herein, but that the invention includes all embodiments falling within the scope of the appended claims.

Appendix I*1. Introduction*

Despite the multitude of advanced technology found in the components of modern skateboards, there is very little technology dedicated to measuring the tricks that skateboarders perform. The old adage due to Lord Kelvin, “if you can’t measure it, you can’t improve it” applies to skateboarders. The skate-hub universal sensor system (shuss) consists of hardware and software that measures the tricks that skateboarders perform.

There are several uses of this shuss . The shuss can be use to “score” or “rate” a particular trick. Unlike the current situation where tricks are based on the opinion of judges, shuss provides an unbiased, objective measure. In addition, the trajectory and motion of the skateboard through space can be visualized, replayed, and compared any number of times on a computer or even a smartphone. This can be used to improve the skaters performance.

The shuss helps to engage a community of skaters with the extended shuss system. Using geolocation and a database, it is possible for individuals to declare themselves “king of the park”. Yet another use of shuss is as a way of engaging a set of visitors to a festival. For example, contestants that can jump higher than a certain amount will win a T-shirt.

Skateboarders, as well as other social sporting activities, like to perform tricks using their skateboards. They practice the tricks over and over, either alone or in groups. They may perform these tricks in a skatepark, playground, or other spaces that have not been designed for skateboarding. They share their tricks, have similar musical interests, and are always in search of new places to try out their tricks. Moreover, skateboarders often buy their equipment from local skateboard shops. Skateboarders usually listen to music while they skate.

Our invention leverages these different and unique characteristics of skateboarders. There are other groups that share these characteristics and so our invention is not limited to skateboarders. The invention involves hardware, mobile devices, and computer services, although we believe that not all components are necessary.

2. The Hardware

There are many different IMU (Inertial Measurement Unit) chips and boards on the market. We assembled an IMU board with the following components:

- a 3D accelerometer (x, y, and z) – triple axis Analog Devices ADXL335
- a single-axis and dual-axis gyroscopes – such as an LY530AL and LPR530AL
- a triple-axis magnetometer – such as the HMC5843

- a bluetooth SMD module
- a rechargeable, LiPo, battery.

Nearly all the surface of a skateboard gets stepped on, grinded, or slammed against some hard physical object. The wheels of a skateboard are attached to the board by something called a truck. A truck has a flat square metal piece that screws to the board. It also has a piece that holds the axel connecting two wheels. There are two trucks to the board. Some boards have a riser or spacer between the truck and the board to give the board more height. The shuss hardware device is placed in this riser and is protected from collisions because it is protected by the truck and the board.

There are several ways to recharge the battery of the device. We use a very long and thin barrel plug. A small cap covers the hole on the riser to keep out dirt and dust.

Two devices can be placed on each board, between each truck. One device is sufficient for most, but not all tricks. Better precision is gotten when using two devices.

The device can transmit the data of all 9 axis using the bluetooth radio, although the magnetometer often gives distorted results due to the metal in the truck. There are times when its results are meaningful and does improve the precision of the measurements.

It communicates with a computer to process the data. In the current system, a laptop running windows 7 os is used. The computer, however, can be either a desktop, laptop, or smart mobile phone. The only requirement is bluetooth support.

The micro-controller on the device is set to transmit either all 9 readings or just 6 (3 accelerometer and 3 gyroscope) all at 100 Hz. Our experiments show that this gives the best precision without exceeding the bluetooth radio's bandwidth.

The next version will allow the computer/smartphone to set the sampling rate.

2.1 Sleep Mode

In order to extend the internal battery of the device, it is important for the device to enter and exit sleep mode. Assume the device is in sleep mode. When the board is moved, the accelerometer generates an interrupt which wakes up the device. The bluetooth turns on and begins to listen. If the computer does not connect to the device within 5 min, the device goes back into sleep mode. At least 1 minute must pass during which there are no interrupts from the accelerometer. After that point, interrupts from the accelerometer will once again wake up the device.

In other words, to get the device to connect to the computer, the device must be quiet for 1 min. Then when the device is moved, the computer establishes contact with the device.

There are many other ways to enter and exit sleep mode. It is easy for some connected bluetooth

machine or smartphone to put the device into sleep mode via a bluetooth command. It is more difficult to have it wakeup. The accelerometer wakes up on movement, and so various patterns can be used to place device into active mode. The bluetooth radio consumes the most power, so that is the component that should stay asleep the longest. It can be awakened when a pattern is detected, such as three taps, two taps, three taps. Or a small switch can be in the device that can be turned on or off by pressing it, maybe with a small sharp stick.

2.2 The controller

The controller on the device performs several functions in its control of the various modules in the device.

Bluetooth is the most complex. Upon master reset and when it is first powered on, the bluetooth module is setup to pair with any other bluetooth device, using a fixed passkey. We use 12345. After its initial pairing, it will always recognize and pair with that device. That first paired device can tell it to pair with others. The first paired device is referred to as its "mother duck" using the analogy of how baby ducklings will assume the first living creature they see is their mother. The mother duck can tell the device to accept new pairings. Otherwise, no other bluetooth pairing request will be acknowledged by the controller. The bluetooth module is set to low power mode requiring the smartphone or computer to be closer than the maximum 10 meters.

The controller also sets and configures each module depending on the firmware. It can compress the data and do other initial analysis to reduce the number of bytes transmitted. For example, it could be programmed to recognize the start of a trick and not transmit until that happens.

2.3 Less precise measurements

Our first version uses a bluetooth chip to communicate with a computer or smartphone. It is also possible to use a wifi radio. A cheaper solution would use a different radio, one that only implements a simple data stream but then another radio would have to be attached to the smartphone or computer.

In our second version, the data will be compressed in order to reduce the number of bytes communicated and thereby reducing the power consumption.

Modern smartphones, such as the iPhone, come with an IMU. These values can be collected on the phone and processed locally or sent to a computer. But since the smartphone is on the person and not the board, the results only measure a portion of the action of the board. Nevertheless, some scoring is possible. In particular, the airtime can be measured as well as the height of a jump. While the rider is on the board that is riding on the ground, there are lots of vibrations caused by the wheels rolling over the uneven surface of the ground. When the board and rider is in the air, these vibrations are reduced. Comparing the raw readings with those of a low pass filter over the data reveal these differences.

3. The Software

Whereas the hardware's role is to gather and transmit the output of the IMU, the software has many more tasks. (1) collect the output values from the IMU, (2) analyze them (3) score them, (4) output summaries (5) interact with user, (6) interact with backend subsystems, (7) handle geolocation, video, pictures, and other smartphone sensor values.

The gyroscope measures rotation and accelerometers measure acceleration. While riding on the ground, the rotational sensors hardly change while the accelerometers are constantly changing due to the vibrations of the wheels on the ground. It is difficult to means position for accelerometers although they can be used to measure the time in free fall (including time going up). Many tricks involve "air" which can be measured as free fall. Nearly all tricks, however, involve the board rotating. For example, an "Ollie" involves an initial flip of the board with the front edge rising and the back edge on the ground. The top edge then bumps into the skaters foot, causing the back edge to rise up. There are two distinct rotations. When the front edge hits the foot, there is a significant change in acceleration (the opposite direction of gravity) and when at the apex, there is another change in acceleration.

High and low pass filters are applied to smooth out the data and Kalman filters are used to smooth out the trajectories. A trick is defined by a sequence of transitions and overlaps of the different gyroscope and accelerometer axis values.

3.1 Skateboard Version of HORSE

Scoring a known trick is easier than identifying and scoring a trick. One engaging game is for the smartphone to randomly generate a series of tricks that the skateboarder must perform. The winner is the skateboarder that gets the highest total score.

3.2 Visualize and learn

We use Panda-3D, an open source 3D game engine written in python to render a display of a skateboard in 3D. Each frame of the game engine allows the board to be repositioned in space before being rendered on the screen. The gyroscope data provides input to the the position of the board in the virtual world of the game.

he user can control the virtual camera angle as well as the frame rate. The user can select to play starting at any particular frame. Thus, the user can see how his or her board was moving while doing a trick. Such information is useful to knowing what was done wrong.

If the location of the trick is known, it is possible to model the physical space as well so that the virtual board can be seen moving in the virtual world in a way that exactly mirrors how the real skateboard moved through the real world. It is possible to overlay two or more iterations of the trick to make it easy to see variations.

4. The Mobile Application

A skateboarder may cover a large area while doing his or her trick. When the shuss is attached to the board, it can accumulate the data but it is also very useful to have the data streamed to some other device in real time.

The shuss needs to conserve power as it is awkward to recharge it's battery. Our approach is to reduce the communication power by having a receiver nearby that can get the data and process it. A smartphone, PDA, or other handheld computer in the riders pocket is the solution.

This mobile device communicates with the device on the skateboard and well as with the user. It may power down the shuss , or indicate which trick is about to be performed. The mobile device collects geolocation information. It uploads the data to a server. Moreover, it interacts with the user telling the score and other status information. It can also show a simulation of the trick in nearly real time.

Two or more riders each with a shuss and mobile can interact and invent two games and competitions.

Accessing a database of tricks by professionals can be used in a variety of ways. It can be used as a teaching tool.

Appendix II

Copy of co-pending, commonly assigned United States Patent Application Serial No.
_____, filed this same day herewith, entitled "Devices, Systems, And Methods for Games,
Sports, Entertainment And Other Activities Of Engagement."

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PROVISIONAL PATENT APPLICATION

FOR

Devices, Systems, And Methods for Games, Sports, Entertainment And Other Activities Of Engagement

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Reference to Related Applications

This claims the benefit of filing of co-pending, commonly assigned United States Patent Application Serial No. 61/370,479, filed August 3, 2010, United States Patent Application Serial No. 61/371,161, filed August 3, 2010, and United States Patent Application Serial No. 61/366,207, filed September 24, 2010, all entitled "DIGITAL DATA PROCESSING SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER SOCIAL SPORTING ACTIVITIES," the teachings of all of which are incorporated by reference herein.

This application is related to co-pending, commonly assigned United States Patent Application Serial No. _____, filed this same day herewith, entitled "Signature-Based Trick Documentation Systems And Methods For Skateboarding And Other Activities Of Motion," the teachings of which are incorporated herein by reference.

Background of the Invention

The invention relates to systems and methods for games, sports, entertainment and other activities of engagement. It has application in entertainment, sports and in training, among other things. Thus, by way of non-limiting example, it has application in training skateboarders in safety, as well as in providing games through which they may gain exercise and entertainment.

Games and sports, as well as the training that make them possible, are among the painful diversions at which persons, communities and nations at peace engage. Technological advances in game, sports and training equipment help stave off contempt of the familiar, while, at the same time, feeding the drive for perfection.

Technology, however, usually follows and rarely leads. Most modern sports equipment, for example, does less to open new avenues of competition as opposed to perfection of old ones. Even video games, which post-date the vast majority of known games and sports, often merely seek to

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Summary of the Invention

The foregoing are among the objects attained by the invention, which provides in some aspects devices, systems, and methods for generating audio for a user/operator and for providing audio feedback in response to user/operator actions in response. Such devices, systems and methods have applications, by way of non-limiting examples, to games, sports, entertainment, training, and other endeavors (including, by way of example, skateboarding, surfing/skateboarding, snowboarding, sailing, rollerblading, and training thereof) as well as to training thereof. Devices, systems and methods according to the invention are advantageous, among other reasons, because they allow users to pursue and/or obtain audio-prompted goals through real-world physical action.

A system according to one such aspect of the invention comprises (i) a sensing device that is attached (or otherwise coupled) to a skateboard and that measures a physical characteristic of it and/or of its environment, (ii) an audio output device, and (iii) a digital data processor that is communicatively coupled to the audio output device and the sensor. The digital data processor drives the audio output device to effect one or more selected sounds (e.g., to prompt the user to perform a selected action). The digital data processor further, and monitors the sensing device to identify user actions in response to those sounds and drives the audio output device to effect still further sounds based on those actions.

Related aspects of the invention provide systems, e.g., as described above, in which the digital data processor drives the audio output to effect sounds as a function of scripts, guidelines, programming or other rules (collectively, "rules") and/or data that (a) define the game, sport, entertainment activity, training exercise or other endeavor for which the skateboard is being used, and/or (b) a virtual sound space in which that endeavor is carried out, i.e., an auditory space, preferably, of three-dimensions, in which everything from other players to characters, to obstacles, to scenery, to the actor representing the skateboard operator, his/her game status, the skateboard movements (or other interactions) with the foregoing are represented to the operators by sounds, yet, where, the user effects those movements and interactions by moving and/or performing

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simulate them in virtual space.

An object of the invention is to provide devices, systems and methods for games, sports, entertainment and other activities of engagement.

A related object of the invention is to provide such devices, systems and methods as open new avenues for such activities, as well as improving existing games, sports and other activities.

A further related object of the invention is to provide such improved devices, systems and methods as have application in skateboarding.

Still further related objects of the invention provide such improved devices, systems and methods as have application in snowboarding, sailing, rollerblading and other activities.

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imaginary, e.g., a dragon, a shouter or a virtual competitor. In other such aspects, it drives the audio output device to simulate sounds of an object whose position and/or actions are based on a real-world object, e.g., another skateboarder (who, too, is equipped with a system according to such aspects of the invention), another person (whether or not on a skateboard), or any other object (e.g., a moving vehicle, an ocean wave, and so forth).

Further aspects of the invention provide systems, e.g., as described above, in which (i) sensing device is coupled to the operator and particularly, for example, his/her shoes, etc., instead or in addition to being coupled to the skateboard, and/or (ii) the data processor is coupled to the skateboard and/or operator, for example, in the form of an add-on or integral module (e.g., in the case of the skateboard) or a clip-on, wearable, pocketable, or carry-along (e.g., in the case of a operator).

In other aspects, the invention provides systems as described above in which the sensing device is attached or otherwise coupled to a surfboard, windsurf board, ski, ski boat, surfboard or other object involving the operator thereof) in lieu of a skateboard (and/or operator thereof)—thus making possible, engaging in other games, sports, entertainment, training and other endeavors.

Further aspects of the invention provide systems, e.g., as described above, in which the sensing device is gyroscope and/or otherwise measures rotation of the skateboard and/or its operator. This can include, for example, gyroscope sensors that measure such rotation, preferably doing at least two—and, still more preferably, along at least three—of x-, y- and z-axes. According to other aspects of the invention, other sensors suitable for detecting rotational and/or other physical characteristics of the skateboard (and/or operator) are used instead or in addition to gyroscope sensors. These include, by way of non-limiting example, accelerometers, magnetometers, global positioning sensors, strain sensors, or other sensors capable of indicating speed, acceleration, jerk, yaw, pitch, roll, or other physical characteristics of the skateboard, its user and/or the environment.

Still further related aspects of the invention provide systems, e.g., as described above, in which

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tricks (or hops) with the skateboard in the real and physical space surrounding him/her.

Further related aspects of the invention provide systems, e.g., as described above, in which the digital data processor drives the audio output to effect sounds defining at least a portion of the virtual sound space in a vicinity of an actor represented by the skateboard and/or its operator. Still further related aspects of the invention provide systems, e.g., as described above, in which the digital data processor drives the audio output to effect sounds reflecting the skateboard operator's (and/or the skateboard's) interaction with that virtual sound space.

Other aspects of the invention provide systems, e.g., as described above, in which the digital data processor drives the audio output device to effect a voice, e.g., commanding the skateboard user to take a particular action—for example, to skate in a designated direction, to perform a specified trick, and so forth). Based on the user's response (e.g., determined by monitoring the sensing device), the digital data processor can drive the audio output device to effect sounds of approval/disapproval or degrees thereof (e.g., applause, hoots, ratings, etc.) and/or to effect a voice commanding further action.

Further related aspects of the invention provide systems, e.g., as described above, in which the digital data processor drives the audio output device to simulate sounds of an object user or (or from the user and/or moving relative thereto). Based on the user's response (e.g., determined by monitoring the sensing device), the digital data processor determines whether the user moved in a prescribed manner relative to the simulated object—for example, increased/decreased a distance to the object, reached a spot representing a location of the object, entered the object, avoided the object, and so forth. Alternatively, or in addition, the digital data processor can determine whether the user performed a trick or other action on the skateboard that is interpreted—e.g., according to rules of a game, sport or other pursuit—as touching, capturing, shooting, firing, or taking some other action with respect to the simulated object.

Still further related aspects of the invention provide systems, e.g., as described above, in which the digital data processor drives the audio output device to simulate sounds of an object that is

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and/or space. Other related aspects of the invention provide such systems in which the server provides data regarding other real-world objects, e.g., other persons, moving vehicles, ocean waves, and so forth, to dashboard-based and/or other systems as described above, e.g., in order to enable their respective digital data processors to drive their respective audio output devices to simulate those objects.

Related aspects of the invention provide sensing devices as described above, e.g., for coupling to a dashboard, surfboard, rollerblade boot, or other object (and/or the equipment thereof) and/or for communication with a data processor as described above.

Related aspects of the invention provide a data processor and/or mobile device incorporating some as described above.

Related aspects of the invention provide a server, laptop, desktop or other data processor as described above.

Related aspects of the invention provide methods of operating one or more of the a sensing device, data processors, mobile device, laptops, desktops and/or server as described above.

Advantages of systems according to the invention are, among others, that they permit upon new screens for play, sport, training or engagement in other endeavors. For example, unlike prior art video game-based systems they do not rely on graphics or other visual effects. Not only does this increase the mobility of systems according to the invention, it decreases their cost, processing and equipment overhead. Moreover, it permits the experience the game, sport, training or other engagement as the same time that user participates in the real and physical world about him/her. In fact, by allowing the user to experience the game "in audio," he or she can direct the rest of his or her senses to, for example, skillfully manipulating the dashboard in the real world. This dual, simultaneous interactions with the virtual sound space and the real world can be harnessed not only to game and sports enthusiasts, but to others, as well, e.g., the vision-impaired, new coaches and others who are training in the ways of their new place of employ, and so forth, all by

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the data processor is disposed remotely from the dashboard, yet, coupled for communications with it (and, more particularly, for example, the sensing device). Such a "remote" data processor can be a dedicated device or it can be part a multifunction device, e.g., as in the case of a data processor that is embedded in a cell phone, personal digital assistant, or other mobile device (collectively, "mobile device"), that performs other functions, e.g., in addition to driving prompts to the audio output device and providing further audio feedback in response to user operations sometimes in response to those prompts.

Further aspects of the invention provide systems, e.g., as described above, in which the sensing device communicates with such a remote data processor wirelessly, e.g., via Bluetooth, WiFi, cellular, infrared or other wireless or wired transmission medium, or otherwise. The data processor can optionally log and/or display measurements received from the sensors), e.g., in addition to driving the audio output device based on those measurements. An advantage of such logging is, for example, that it makes possible validating what games, sports or other endeavor the respondent effected on the dashboard (or other object) as well, for example, as the success of that endeavor.

Not still other aspects of the invention provide systems, e.g., as described above, that includes two (or more) data processors, e.g., one that is coupled to the dashboard and/or operator, and one that is disposed remotely. The two (or more) data processors can be coupled for communications via wire and/or wirelessly. They may, moreover, share and/or divide up one or more of the tasks attributed to the "data processor" or "server" in this summary and elsewhere herein. Thus, for example, according to one such aspect of the invention, an "on-board" data processor that is coupled to the dashboard identifies tracks and other movements based on measurements made by the sensing device and routes those identifications to the remote digital data processor, for further processing by it to generate sound prompts (or responses thereof) that are, in turn, routed back to the on-board data processor which drives the audio output device.

Further related aspects of the invention provide systems, for example, as described above, in which the server exchanges data between and/or among systems according to the invention, e.g., thereby, for example, enabling the playing of games among enthusiasts that are separated by time

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Audio Perceived

Brief of Illustrated Embodiment

A more complete understanding of the invention may be attained by reference to the drawings, in which:

Figure 1A-1H depict a system according to the invention for generating audio prompts to a sketched user and for providing audio feedback in response to his/her actions in response to those prompts;

Figures 2A-2B schematically depict a sensing device according to the invention for use in the system of Figure 1;

Figure 3 depicts an aspect of such identification in a system according to the invention; and

Figure 4 is a flowchart depicting operation of a digital data processor according to one practice of the invention enabling an operator to use a sketched and system to engage in a voice-prompted, one-person (or "single-player") game, sport, entertainment activity, training exercise or other endeavor in a virtual sound space.

FIG. 1A-1H are schematic diagrams of a system according to the invention for generating audio prompts to a sketched user and for providing audio feedback in response to his/her actions in response to those prompts.

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enthusiasm, devices, systems and methods according to the invention enhance competition between and among such enthusiasts—even those separated by time and space.

Audio-Enhanced Gaming

Figure 1A depicts a system 10 according to one practice of the invention for physically interactive audio gaming. Other embodiments employing the teachings herein and within the ken of those of ordinary skill in the art may be utilized for identifying other feats of motion of the user alone or in connection with other objects. Non-limiting examples of other such objects (and feats of motion) include, *inter alia*, neighborhoods, neighborhoods, skills, and neighborhoods, among others.

The illustrated system includes one or more sensing devices 40 (also referred to here as measurement devices) that are attached to a skateboard 20 and that are in communications coupling with one or more digital data processors, here, in this drawing, represented by digital data processor 60. The illustrated system further includes an audio output device, e.g., such as earphones 40a.

Sensing Devices

The sensing devices 40 measure position, motion and/or other physical characteristics of the skateboard 20 and/or its environment. Position measurements can include absolute or relative position (e.g., as determined in accord with GPS satellite signals or otherwise), linear or in rotation—including, by way of non-limiting example, location, orientation and/or altitude. Referring to the annotated axes 11 shown in Figure 1A, motion measurements can include linear motion and/or rotation motion, including, for example:

- 1) roll (denoted "R", in the drawing)—total angular displacement about the longest principle axis N of the skateboard given relative positioning of the sensors to the skateboard;
- 2) pitch P—total angular displacement about the second principle axis Y of the skateboard

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Detailed Description of the Illustrated Embodiment

By way of example, according to the invention computer hardware and/or software that generate audio for games, sports, entertainment, training and other endeavors and that provide audio feedback in response to the user's actions in response to those prompts. As noted above, such systems (as well as the underlying devices and methods) are advantageous, among other reasons, because they allow users to pursue and/or obtain audio-prompted goals through real-world physical action without loss of generality; they are referred to herein as systems for "audio games," "physically interactive audio games," and so forth, as will be evident below.

For sake of convenience, and without loss of generality, such systems are described in connection with skateboarding in much of the discussion below, though, it will be appreciated that the invention can be used in connection with games, sports, entertainment, training and other endeavors such as skateboarding, snowboarding, skiing, and rollerblading, among others).

Unlike the prior art, in which the technology merely used to enhance known games, sports, entertainment, training and other experiences, devices, systems and methods according to the invention additionally open new avenues of play, e.g., by combining physical activity with virtual spaces—and, particularly, with auditory virtual spaces. Such devices, systems and methods make possible, for example, engagement in games, sports, entertainment, training and other endeavors in virtual sound spaces (or "virtual sound worlds")—e.g., auditory spaces defined by sound—preferably, in three-dimensions—i.e., an auditory space, preferably, of three-dimensions, in which everything from other players, to characters, to obstacles, to scenery, to the user representing the skateboard operator, to other game items, the skateboard movements (or other interactions) with the foregoing are represented to the operator by sounds—yet, where, the user of even those movements and interactions by moving and/or performing tricks (or feats) with that skateboard in the real and physical space surrounding him/her.

In addition to enhancing and/or opening new avenues for play, sport and/or training by individual

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The sensing devices 40 can be coupled in any portion of the skateboard 20—though, in some embodiments, placement is dictated by several factors related to standard use cases; where on the board will the sensing devices experience the least damage, what is least intrusive to the skateboarding experience, and what is most aesthetically pleasing.

Significantly, placement is also dictated by location(s) that facilitate measurement by sensing devices 40 (e.g., accelerometers), e.g., as optimized for the particular motions upon which operators are likely to rely during engagement in games, sports, entertainment, training and other endeavors.

For example, in embodiments that support trick detection (e.g., that permit the skateboard operator to incorporate tricks into game play—such as, for example, the execution of an “ollie” to shoot game characters that are nearby in the virtual sound space established by the system) these are locations that are best interpreted by data processor 40 to identify tricks performed on a skateboard (and/or to otherwise provide for the meaningful generation of data pertaining to the skateboard). In this regard, placement can be made in accord with an analytic solution to the three coupled differential equations for rigid body motion known as Euler's equations. Precise placement in this regard is not critical, however, since the set of motions that constitute skateboard tricks is sufficiently limited to admit coarser methods of distinction (and, hence, allowing more weight to be given to the other placement factors).

By placing the sensing devices on the skateboard asymmetrically along its longest principle axis and approximately symmetrically along the remaining two principle axes one can sense the rotational acceleration in the rotating frame necessarily experienced when the skateboard rotates about a nonprinciple axis during a trick. This hinges on how limited the class of rigid body motions that constitute tricks to any trick that does not rotate solely about a principle axis necessarily has largest angular velocity in roll and registers non-zero angular velocity about all three principle axes for the duration of a trick. In the standard language of skateboarding the first of these characterizations is tantamount to saying that if two tricks that rotate about a single principle axis

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parallel in the ground when the skateboard is at rest on its wheels.

- 3) yaw (“N”) – used angular displacement about the principle axis Z of the skateboard perpendicular to the ground when the skateboard is at rest on its wheels.
- 4) acceleration – acceleration detected along the longest axis X of the skateboard.
- 5) initial pitch – the sign of the pitch P detected nearest the start point of the data window. In the drawing, that sign is indicated by “+” and “-” signs adjacent ends of the curved arrow denoting the pitch P.

Other motion measurements can include speed, jerk, among others. Other characterizations of the skateboard can include orientation of the operator/hunter, weight of the operator/hunter and/or other forces and strains on the skateboard, temperature and wind speed, all by way of non-limiting example.

The sensing devices 40 can comprise conventional sensors of the type for measuring linear and/or rotational position and/or motion known in the art, as adapted in accord with the teachings hereof. Thus, for example, the devices 40 may comprise GPS sensors, accelerometers, gyroscopes, magnetometers, temperature sensors, strain sensors, optical sensors, acoustic sensors, RFID (radio frequency identification) and so forth embodied in microelectromechanical systems (MEMS) or otherwise, and all as adapted in accord with the teachings hereof. For example, in some embodiments, optical sensors are utilized alone—or, for example, with LED lasers or other light-emitting devices—as fail-safe detecting when the skateboard 20 is engaged in a “grind.” By way of further example, in some embodiments, an RFID receiver chip attached to the skateboard 20 can be used in conjunction with an RFID transmitter chip attached to the user's shoes (or elsewhere) to facilitate (i) identification and/or orientation of the user.

FIG. 22

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In the illustrated embodiment, the pad 24 is mounted in a cavity 22A of the deck 22 such that the cover 24C is accessible from the top of the deck (i.e., the side opposite the deck from the track 26 and wheels 28) and such that the base 24A is accessible—and, preferably, sturdy proof from—the bottom of the deck 22. The latter permits, in some embodiments, mounting of the track 26 to the base 24A and, in some embodiments, exposes a port (not shown here), e.g., a charging port and/or data port, for access by the operator when the board 30 is not in use.

Consistent with the discussion above, the pad 24 and, particularly, the body portion 24B thereof are disposed within deck 22 such that sensing devices 40 mounted within the pad 24 are disposed asymmetrically along the longest principle axis X of the skateboard, while being approximately symmetrically disposed along the remaining two principle axes Y and Z, as shown. Though shown in an open configuration in the drawing, during normal use of the skateboard 30, the body of spacer 24 is disposed in recess 22A and is closed.

Portions 24A, 24B may be formed of metal, plastic, wood, carbon fiber or other material of suitable durability, e.g., for permanent or semi-permanent affixation in deck 22 and for mounting of track 26, as shown in Figure 1A. Cover 24C is preferably formed of plastic, wood or other material sufficiently durable to withstand pounding, rubbing or other contact by the operator, yet, which does not interfere with wireless communications, e.g., within sensing devices 40 disposed within the pad 24. The various portions 24A—24C, preferably includes seals, e.g., O-rings, or the like, that prevent water, dirt and other contaminants from entering the body and, thereby, housing sensing devices 40 therein.

Multiple Sensing Devices

In some embodiments, more than one array of sensing devices 40 are be coupled to the skateboard to allow for additional data to be generated regarding the characteristic(s) of interest. For example, a skateboard 20 can have sensing devices, e.g., in spacers 24 that reside above the trucks of both the front and back wheels. In fact, in some embodiments, one or more of these sensing devices 40 is disposed on the underside of the skateboard, e.g., on a shoe, foot, sock,

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are combined, one of them will be a kickflip or a heelflip

This partially symmetric placement of sensors can be used to detect centrifugal acceleration of the skateboard 20 (or other object) along its longest principle axis, which in turn is useful in developing a myriad of course yet unambiguous classifications of rigid body motion. The outlined sensor placement criteria has broad application in many fields outside of skateboarding. Indeed, any activity of motion involving a rigid body that has a distinctly long principle axis would benefit from this scheme in tracking and classifying rigid body motion.

Base Pad (Figure 1B)

Referring to Figure 1B, the sensing devices 40 can be embedded, mounted or otherwise fixed to the tracks 26, which connect wheels 28 to deck 22. Alternatively, the devices 40 can be affixed to a surface of the deck 22 or elsewhere on the skateboard.

Regardless, the sensing devices are preferably mounted to the skateboard 20 in a manner that achieves the desired placement while, at the same time, (i) protecting the devices 40 from damage as the skateboard is stepped upon, gripped and/or slammed during use (e.g., jumped upon by the user, gripped against stair rails, slammed against curbs, and so forth), (ii) permitting access to batteries, sensors and associated logic of the sensing devices 40, (iii) permitting transmission of wireless signals to/from the sensing devices, e.g., without requiring signal penetration through the track 26, which is typically metal, and/or (iv) permitting exchanging of batteries for the devices 40, uploading of data and/or control software, and/or downloading of data.

A base pad 24 that achieves the foregoing is illustrated in Figure 1B. This pad 24, which is generally of a “clamshell” design, includes a base portion 24A, a body portion 24B, and a cover 24C. These portions may be hinged to one another, as shown in the drawing, though this is not the case of all embodiments. And, while the cover 24C is preferably removable from the other portions 24A, 24B, these other portions may, indeed, be formed as one.

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medium, or otherwise) with the sensing devices 40 and/or another data processor (e.g., an embedded microprocessor) that is itself in communications coupling with those devices 40.

Sensing Devices 40 (FIG. 2)

As noted above in connection with Figure 1, the sensing devices 40 can comprise conventional sensors of the type known in the art for measuring position, motion and/or other physical characteristics of the sketched 20 and/or its environment, as adapted in accord with the teachings hereof. Thus, for example, the devices 40 may comprise GPS sensors, accelerometers, gyroscopes, magnetometers, temperature sensors, strain sensors, and so forth, embodied in microelectromechanical systems (MEMS) or otherwise, and all as adapted in accord with the teachings hereof.

Referring to Figure 2A, the sensing devices 40 of the illustrated embodiment comprise linear accelerometer sensor 40a and rotational sensors 40b-40d for measuring, respectively, acceleration along the longest axis X of the sketched 20; roll (angular displacement about axis X), pitch (angular displacement about axis Y) and yaw (angular displacement about axis Z). As noted above, other embodiments may use other sensors, e.g., GPS sensors, magnetometers, temperature sensors, strain sensors, instead or in addition.

Illustrated sensing devices 40 may form part of an internal measurement unit or otherwise, and they may be fabricated embodied in microelectromechanical systems (MEMS) or otherwise. In one embodiment, the rotational sensors 40b-40d are embodied in an STMicroelectronics L3GD45HD three-axis angular rate sensor, while sensor 40a is embodied in an Analog Devices ADXL345 three-axis accelerometer. These, however, are design choices, from which others skilled in the art may vary in accord with the teachings hereof.

Packaged with the sensors 40a-40d of the illustrated embodiment are microprocessor 44, battery 46, and wireless communication module 48. Together with an appropriate substrate and supporting circuitry, these components form a printed circuit board (PCB) 42 that, in the illustrated em-

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port (e.g., belt, backpack, and so forth), in order to provide further data for identifying tracks performed on a sketched and/or for otherwise generating, transmitting, and analyzing data pertaining to motion of the sketched.

Digital Data Processor 60

The sensing devices 40 communicate collected measurements to one or more digital data processors—here, depicted as digital data processor 60—for (a) analysis in view of scripts, guidelines, programming or other rules (collectively, “rules”) and/or data that define (i) the game, sport, entertainment activity, training exercise or other endeavor for which the sketched 20 is being used, and/or (ii) the virtual sound space in which that endeavor is embodied, and (b) deriving the audio output device 60a to effect sounds embodying at least a portion that virtual sound space (e.g., in a vicinity of the actor represented by the sketched 20 and/or its operator) and/or the sketched operator's interaction with that virtual sound space, e.g., as he or she effects moves and/or performs tricks (or runs) with the sketched in the real and physical space surrounding him/her. In addition, the digital data processor can collect those measurements for logging, display and/or retransmission to other devices.

The data processor(s) can comprise a dedicated device, such as a dedicated microprocessor (or “controller”) that is embodied with the sensing devices 40, e.g., on the sketched 20, and/or that is housed separately from the sensing devices albeit coupled for communications via Bluetooth, WiFi, cellular, infrared or other wireless or wired transmission medium, or otherwise. An example of the former is microprocessor 44 of Figure 2. An example of the latter is the digital data processor 60 shown in Figure 1 and discussed, e.g., in the section belows entitled “Digital Data Processor.”

Alternatively, or in addition, the data processor(s) 60 can be part a multifunction device, e.g., in the case of a data processor that is embodied in a cell phone, personal digital assistant, or other mobile device (collectively, “mobile device”) and that is in communications coupling (e.g., for example, via Bluetooth, WiFi, cellular, infrared, or other wireless or wired transmission

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or otherwise to prevent contamination). In other embodiments, recharging may be provided for via a standard power adapter port, via inductive charging or otherwise.

Communication Module 46 enables the transfer of software

Communication module 46 enables the transfer of software (e.g., for purposes of reprogramming the unit 42), control parameter and/or data between the unit 42 and, particularly, for example, the sensors 48a-48d and/or microprocessor 44) and external devices, e.g., digital data processor 60). The module 46 can support wired transfers, e.g., via the aforementioned USB port or otherwise. In preferred embodiments, it supports wireless transmissions, instead or in addition. This can include Bluetooth, WiFi, cellular, infrared or other wireless protocols.

Module 46 can be constructed and operated in the conventional manner known in the art suitable for supporting the aforesaid and other wired and wireless protocols, as adapted in accord with the teachings herein.

Software of the type suitable for execution by microprocessor 44 to effect operation of module 46 of the illustrated embodiment is provided below. It will be appreciated that this represents but one technique for configuring the microprocessor 44 to support such operation and that other techniques for configuring the microprocessor are within the scope of the invention.

```

% DOCUMENT 43
%
% Communications with 380 through Bluetooth network, logs data to files.
% format comma-separated, newline-separated, divided lines of raw and
% second data
% raw very basic error detection and alignment and circuit buffering

import bluetooth
import time
import array
import numpy as np

def get_data_selection_of_380_addresses():
    # get the addresses of the 380 addresses to be selected
    # each device = bluetooth address of device
    if len(device_addresses) == 0:
        print "Found no discoverable Bluetooth devices!"
        return None
    
```

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embodiment, has a form factor of the type as shown in Figure 2B—a more complete understanding of which PCB may be obtained by reference to the schematic of Appendix 1 herein. Of course, other embodiments may package these components in other ways—e.g., on PCBs of other configurations, on chips, in separate PCBs, and otherwise).

While not shown in the illustrated embodiment, the sensing devices can additionally include a pressure sensor (based on piezo-electric or otherwise). This can be housed on PCB 42, though, more typically, it is mounted directly to disk 22 in order to detect when there is a user on the skateboard 20, when the user is landing on the board (e.g., after a jump), when the user and board are both in free-flight and/or when the user falls off the board. Output from the pressure sensor can be used in conjunction with track determination, e.g., along the lines discussed below and/or it can be reported (directly or by way of microprocessor 44) to digital data processor 60 as another “measured characteristic” of the board 20.

The device 42 can also incorporate the audio output module 48a discussed above in connection with Figure 1.

Battery

Battery (or other power source) 48 provides power for operation of unit 42 and/or the constituent elements thereof. This is a conventional battery (or other power source) of the type known in the art for household or light industrial use, though other batteries and/or power sources may be used as well or in addition—off as adapted in accord with the teachings herein. Suitable batteries include, for example, alkaline, nickel-metal hydride, nickel-cadmium, lithium, carbon zinc, and so forth. Preferably, battery 48 is rechargeable and/or removable (e.g., via opening of clear cover 24c).

In the illustrated embodiment, battery 48 may be recharged (and its charge, for example, checked) via application of power to a USB port on unit 42, means in which may be gained via the base 24a or cover 24c of the case 24. (That access may be covered, e.g., by a removable plug

Audio Processing

operational LED and/or display panel (not shown) and/or audio output of unit 42 in case of such detection.

In some embodiments, processing of data generated by sensors 40a-40d is the province of separate digital data processor 60. In embodiments that support trick detection, such as the illustrated embodiment, that function is performed by microprocessor 44—specifically, the identification of tricks (or other facts) performed on the skateboard 20 (or other object).

The illustrated microprocessor 44 also performs control associated with such trick (fact) identification. This includes, by way of example, powering-up or waking the sensors 40a-40d in response to user activation—e.g., double-tapping of the skateboard 20 by the user. This also includes, by way of example, detecting trick (or fact) start, e.g., based on peak detection or other characteristic changes in forces or motions measured by the sensors. And, it includes by way of example, uploading the identity of detected tricks to the digital data processor 60, e.g., along with underlying or other sensor readings.

In this latter regard, for example, the microprocessor 44 can effect uploading of the identity of an identified trick to the digital data processor 60, along with position information from a GPS sensor (not shown), time/date information from an onboard clock (not shown), maximum velocity and acceleration readings sensor 42a, and so forth—all by way of example. By way of further example, microprocessor 44 can effect uploading of a log of collected sensor readings, if it is unable to identify therefrom a particular trick—or, in some embodiments, even if it is able to identify a trick.

Instead of, or in addition to, uploading trick identity under underlying or other sensor readings, the microprocessor can effect notification when pre-selected trick(s) or facts—such as, in the case of skateboard 20, an “Ollie”—are identified. Such notification can be transmitted to the digital data processor 60. Alternatively or in addition, such notification can be effected via an alert to the aforementioned operational LED and/or display panel (not shown) of unit 42 to the aforementioned audio output module 40a, or otherwise. Indeed, such a notification can be trans-

Audio Processing

mitted microprocessor 44 controls and/or configures the unit 42 and/or the constituent elements thereof. The microprocessor 44 can perform any number of functions, as will appreciated by a person skilled in the art, depending on the particular application for which the sensing devices 40 are used. By way of non-limiting example, the microprocessor 44 can power-up, power-down, “sleep,” reset, reinitialize, and/or set operational parameters (including, level setting) for unit 42, module 46 and/or sensors 40a-40d. By way of further example, microprocessor 44 can effect software, control parameter and/or data transfer between digital data processor 60 and unit 42, module 46 and/or sensors 40a-40d.

Thus, for example, in order to extend the life of the battery 48, the microprocessor 44 can control—e.g., by the communication module 46 to enter sleep mode during non-use or inactivity, e.g., if the communication module 46 is unable to connect to the digital data processor 60 for a pre-determined time (e.g., five minutes). In response to a command from that processor 60, in response to a user identification command (e.g., a triple-tap on the skateboard 20). And by way of further example, the microprocessor 44 can configure the communications module 48 to operate in lower power mode when practical. To further extend battery 48 life, the microprocessor 44 preferably activates the sensing devices 40 independently of the communication module.

As will be appreciated by those skilled in the art, various ones of the control and/or configuration operations attributed to the microprocessor 44 may be handled via other functionality in the module 42. Thus, for example, one or more parameters may be burned into read-only memory modules (not shown) provided with the unit 42, may be “hardwired” into circuitry of the PCB, or otherwise, all consistent with the teachings herein.

By way of further example, microprocessor 44 can perform data conditioning (e.g., normalization), data reduction, data compression and other preprocessing of data from sensors 40a-40d before it is sent to digital data processor 60. It can also detect fault in operation of the unit 42, module 46 and/or sensors 40a-40d, forcing notification to digital data processor 60 and/or to an

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threshold, then microprocessor 44 proceeds to compare the data in the identified data window to the signature of what is expected for each tick.

In the illustrated embodiment, there are n salient features of gyroscope and accelerometer data used to identify ticks, and each tick is assigned a collection of n -tuples. Each tuple is assigned to a particular tick is considered a signature of that tick. If one of the signatures of a tick appears in a data window, that tick is registered as detected.

Referring back to Figure 1, in the illustrated embodiment, the salient features are:

- 1) roll (denoted "R", in the drawing) - total angular displacement about the longest principle axis X of the skateboard given relative positioning of the sensors to the skateboard;
- 2) pitch P - total angular displacement about the second principle axis Y of the skateboard parallel to the ground when the skateboard is at rest on its wheels;
- 3) yaw ("Y") - total angular displacement about the principle axis Z of the skateboard perpendicular to the ground when the skateboard is at rest on its wheels;
- 4) acceleration - acceleration detected along the longest axis X of the skateboard;
- 5) initial pitch - the sign of the pitch P detected nearest the start point of the data window in the drawing, that sign is indicated by "+" and "-" signs adjacent ends of the curved arrow denoting the pitch P.

Each of these features, or "parameters," is bounded by thresholds and has between three and six modes. Referring to Figure 1, the gray areas indicate the thresholds within which a given tick relating about the longest principle axis (having roll) would be recognized.

Each of these parameters assumes a value specifying what range, given threshold, certain aspects

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mined or otherwise effected when the processor detects an unexpected, but failed, tick.

Tick Detection

As noted above, in the illustrated embodiment microprocessor 44 processes of data generated by those sensors 40 to identify ticks (or other items) performed on the skateboard 20 (or other object). An appreciation of this may be gained by reference to the discussion that follows, as well as that provided elsewhere herein. Though attributed to microprocessor 44, it will appreciate that tick (item) detection can be performed by digital data processor 40 or other functionality, all in accord with the teachings herein.

In the illustrated embodiment, the microprocessor 44 begins tick identification with processing data from the gyroscopes 40b-40d and accelerometers 40a to determine what segment, or "data window", of a data stream to compare against what an expected tick signature (i.e., what a tick is expected to look like in terms of sensor data).

In order to locate such data windows, the illustrated microprocessor 44 first sets a threshold for angular displacement. If the magnitude of angular displacement sensed by the gyroscopes is beyond this threshold about any axis, microprocessor 44 considers this a potential start point of a data window in which to identify ticks.

To determine a potential end point of a data window, the microprocessor 44 sets a separate threshold on the rate of change of angular displacement. This relies on the assumption that when a tick is landed the skateboard 20 suddenly stops rotating (i.e., when it is "caught" by the user); this causes sharp fluctuations in angular displacement data.

Once a start point and end point have been identified, a final step in identifying a data window is to check that a "reasonable" amount of time has passed from the start point to the endpoint. Again, microprocessor 44 sets a threshold on the difference of the time stamp on a potential end point and the time stamp on a potential start point. If this difference is greater than the time

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principle axis happens the fastest. Since the gyroscopes are fixed to the skateboard, this means that during the course of a trick the angular velocity registered by the sensors about, say, the principle axis corresponding to yaw will exhibit sinusoidal behavior. Likewise for pitch. This makes physical sense, yet confounds the intuition of the typical skateboarder. For example, conventionally a viral flip is described as 360 degrees of roll (a kickflip) combined with 180 degrees of yaw (a shuvit). However, gyroscope data taken during the course of a viral flip results in roughly 360 degrees of roll and two out of phase sinusoids for pitch and yaw. Difficulty arises when one tries to distinguish tricks which conventionally differ by a 180 degree rotation in yaw, for example the viral flip and the 360 flip (360 degrees in roll and 360 degrees in yaw). The “shape” of the gyroscope data is roughly the same, and differs mostly in the amplitudes of the sinusoids. These amplitudes do not readily yield to the same methods of setting thresholds using its parameters (1) - (3). Instead, here the microprocessor 44 exploits the asymmetric position of the sensors on the skateboard to detect counterfugal acceleration.

Parameter (4) reflects the accelerometer data from the longest axis of the skateboard. The accelerometer experiences a centrifugal acceleration that is proportional to the square of the angular velocity registered in pitch and yaw by the gyroscopes, as exemplified by the relations below:

$$v = r^2 \Omega$$

$$a = v^2 / r$$

$$a = r^2 * \Omega^2 / r$$

In this way, the difference tricks intuitively described as being a 180 degree rotation in yaw differ most become clear. Notice that if the sensors were placed symmetrically on the body, no centrifugal acceleration would be measured and such a scheme of detection would be impossible.

Parameter (5) reflects the initial direction of pitch, either positive, negative or zero. Practically,

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of gyroscope and accelerometer data fall in. Each combination of values for each parameter unequivocally specifies the type of motion a skateboard has undergone during a data window, whether it be a trick or not.

Parameter (1) reflects how much roll, if any, the skateboard rotates through during the data window. Practically, this is measuring how much kickflip or heelflip has happened during a trick. Notice that any trick that does not rotate primarily about a principle axis necessarily has some non-zero roll. Also, the skateboard rotates most easily about its longest principle axis, since the skateboard has the smallest moment of inertia in this dimension. For these reasons, parameter (1), unlike parameters (2) and (3), is useful for identifying and differentiating tricks that rotate about a single principle axis (namely the longest axis of the skateboard) and tricks that combine rotations about more than one principle axis, such as a viral flip or a 360 flip. The angular velocity in roll is roughly constant for the bulk of a given data window, and the thresholds on parameter (1) determine practically how many kickflip or heelflip rotations have occurred during the course of trick.

Parameter (2) is similar to (1), but reflects the amount of pitch the skateboard rotates through during the data window. Parameter (2) differs from (1) in that it is only useful in determining if rotation about a single principle axis is enough for a trick to have been completed. Practically, this amounts to determining whether a data window contains data for an impossible or a foot impossible. Tricks that rotate about a non-principle axis do make gyroscopes register pitch, but in a non-obvious way. This behavior is addressed by parameter (4).

Parameter (3) is entirely similar to parameter (2), save that the information it encodes is the angular displacement about the third principle axis, or yaw. Practically this amounts to determining whether a data window contains data for a shove, frontside or backside, and how much. Again, for tricks that rotate about a non-principle axis yaw exhibits non-obvious behavior and captured by parameter (4).

For tricks that rotate about a non-principle axis, as measured above, rotation about the longest

Abstract

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[illegible]

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lessly, "mobile device").

It includes one or more modules for the receiving, transmitting, processing, storage, generation and/or display of data of the type conventionally associated with such dedicated and/or multifunction devices, all as adapted in accord with the teachings herein. For example, the data processor 60 can include a store that is configured and operated utilizing conventional database techniques (as adapted accord with the teachings herein) to record information regarding identified tracks and/or characteristics of the skateboard and/or its environment measured by the sensing device 40, e.g., for later access by the skateboard user or others.

It can also include an audio output device or module 60a that generates an audio output (e.g., a song and/or a sound or series of sounds), e.g., in response to information received from the skateboard and/or the other nodes (if any) in response to user prompts, or otherwise.

As shown in the drawing, data processor 60 is in communications coupling with the skateboard 20 and, more particularly, unit 42, and still more particularly, for example, microprocessor 44 and/or sensing device 40, e.g., via Bluetooth, WiFi, cellular, infrared, or other wireless link—though, in other embodiments such coupling may be wired, instead or in addition.

In an exemplary embodiment, the digital data processor 60 is a smart phone having a communication module capable of receiving the wireless communication signals generated by the sensing device 40. The smart phone can be held, for example, in a skateboarder's pocket within transmission range of the sensing device 40. Alternatively, the digital data processor 60 can be stationary when the skateboard 20 is not. For example, the digital data processor 60 (whether a smartphone, laptop or otherwise) that is positioned in proximity to a ramp or jump on which tracks and/or other characteristics of the skateboard will be determined. In some embodiments, the sensing device 40 can buffer or store information for transmission to the digital data processor 60 until the two devices are brought within range or otherwise placed in communications coupling (e.g., via wired connection and/or user command).

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erwise.

- Obtain information defining the play, sport, entertainment activity or other endeavor—e.g., more typically, defining the positions/actions of other players, characters, obstacles, scenery, etc., that make up the virtual sound space—then external sources, e.g., other "nodes" (as discussed below), central servers, central stores, the Internet, or otherwise. This can include, for example, other skateboards (who, too, may be equipped with a system ID), another person (whether or not on a skateboard), or any other entity (e.g., a moving vehicle, an ocean wave, and so forth).

In some embodiments, a given data processor 60 (e.g., a cell phone, PDA or computer) may be capable of operation with multiple different skateboards (or other objects) 20, concurrently or one-at-a-time. This can facilitate, for example, the use of a cell phone 60 with multiple objects (e.g., skateboards, surfboards, etc.) equipped in accord with the teachings and owned by the given user or, conversely, by multiple such objects owned by different persons (e.g., friends, competitors, etc.).

Moreover, in some embodiments, the microprocessor 44, unit 42 and/or cell phone (or digital data processor) 60 are equipped to communicate to one another and/or to central servers, central stores, and/or other nodes, or otherwise via a mesh network, established among themselves or otherwise. This can, for example, facilitate communication among skateboards 20 in the same recreational park, e.g., when only a few of the users have cell phones.

Communication

Referring back to Figure 1, data processor 60 can comprise a dedicated device (e.g., a desktop or laptop computer) or it can be part of a multifunction device, e.g., as in the case of a data processor that is embedded in a cell phone, personal digital assistant, or other mobile device (e.g.,

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can be sped up or slowed down in response to the speeding up or slowing down, respectively, of the skateboard 20. An increase in height (e.g., a jump), for example, of the skateboard 20 can amplify the high tones of the audio output, while a decrease in height (e.g., a landing) can amplify the low tones. Variations in the audio output can also prompt the user (e.g., skateboarder), for example, to perform a certain task, to go, speed up) or alert the user to attempt a new action.

In this way, the digital data processor 60 can be used as a learning tool. In reference to a certain action desired to be performed by a skateboarder, for example, the audio output device can generate the audio output (e.g., a signal) to alert the user to perform a sequence of actions, or perform the next in a sequence of actions, in order to attain the desired characteristics).

In addition to, or in the alternative to, outputting the audio output in real-time, the digital data processor 60 can associate an audio signal with identified tricks and/or characteristics of the skateboard and/or its environment measured by the sensing devices 40. If the user (or another) subsequently executes a saved record of that trick or other characteristic, the digital data processor 60 or other device can replay the associated audio signal—e.g., allowing the user or another to relive the occasion.

Game Play

Figure 4 is a flowchart depicting operation of a digital data processor 60 according to one practice of the invention enabling an operator to use skateboard 20 and system 10 to engage in a voice prompted, one-person (or “single-player”) game, sport, entertainment activity, training exercise or other endeavor in a virtual sound space. For sake of simplicity and without loss of generality, the endeavor is referred to below and in the drawing as a “game.”

In step 40, the user mounts the skateboard and activates the audio output device 40. This may include activating speakers and/or inserting earphones, depending upon implementation. In embodiments where the processor 60 executes on a mobile device, the user may also choose to place that device in a pocket or backpack, e.g., to take advantage of its onboard speaker, to facil-

Audio Output

In one embodiment, the digital data processor 60 includes an audio output module 60a that generates audio output, e.g., a song selected by the user, a pre-recorded sound, a synthesized sound, or otherwise. The module 60a may comprise one or more speakers that are embedded with microprocessors 44, e.g., on the skateboard 20, and/or that are housed separately from 20, either coupled for communications via Bluetooth, infrared or other wireless or wired transmission medium. Alternatively, or in addition, module 60a can be part mobile device that is in communications coupling (e.g., via Bluetooth, Wi-Fi, cellular, infrared, or other wireless or wired transmission medium, or otherwise) with the digital data processor 60. Regardless, the module 60a may be coupled for mono playback, stereo playback (e.g., as via the headphones illustrated in Figure 1) or otherwise.

Audio output may be activated by the user and its volume, duration or other characteristics controlled by way of a switch (not shown) or otherwise. Alternatively, or in addition, the audio output can be a sound or series of sounds generated in response to data received by the digital data processor 60 from the sensing device 40 regarding a trick or characteristic of the skateboard 20.

For instance, as the skateboard user performs a specific trick, or the skateboard attains a certain characteristic (e.g., a pre-determined speed, height, etc.), the digital data processor 60 can control the audio output device to generate a sound or series of sounds to alert the user. For example, when unit 42 detects that the user is performing an “offie,” the digital data processor 60 can cause the audio output device to generate a loud crashing noise when the skateboarder kicks down on the back edge of the skateboard. By way of another non-limiting example, the digital data processor can cause the audio output device to generate a “whirring” sound when the skateboard 20 is being spun.

In another exemplary embodiment, digital data processor can cause the audio output device to generate an audio output (e.g., a song with a given rhythm) that is manipulated based on the characteristic(s) of the skateboard 20. By way of non-limiting example, the playback of the song

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about, stationary or moving, beside or behind him/her—all by way of non-thinking example, and (ii) effect a voice commanding the skateboard user to take a particular action with respect to that target—for example, to skate in a designated direction to perform a specified trick, and so forth.

In step 90, the user attempts to perform the commanded act using the skateboard 20.

In step 92, the game-playing software monitors information from unit 42, and will more particularly, for example, microprocessor 44 and/or sensing devices 46 to determine the user's progress toward performing the commanded act. This can include deriving the audio output device to reflect changes in the soundscape and/or the audio representation of the target indicative of the user's progress, e.g., making the target sound closer or further, moving from one side to the other relative to the user, and so forth. It can also include sounding hear strikes, grinds, hits, near misses and so forth as other users in the game interact with one another and/or with the user represented by the user and vice versa. This can also include detecting whether the user succeeds or fails in performing the designated act, e.g., moved the skateboard as directed, performed the specified trick, and so forth.

In regard to the foregoing, the digital data processor 60 and, more particularly, the game-playing software translates the user's movements and/or tricks (focus) with the skateboard into actions by the user represented by him in the game. Thus, for example, as the user rolls the skateboard forward in the physical world, his/her avatar in the virtual sound space moves forward, with a corresponding change in the soundscape and from those other actors, obstacles, scenery, etc., thereby, when the user turns the skateboard to the left in the physical world, he/she hears sounds as if his/her respective characters turned left in the virtual world, and so forth—all depending on the rules of the game. Moreover, for some games the processor and game playing software may even track or focus on the skateboard 20 in the physical world as actions in the virtual sound world, e.g., tracking, capturing, shooting, fleeing, or taking some other action with respect to the virtual object. For example, some tricks may translate to offensive strikes (grinds, hits, throws, etc.) in the virtual sound space, other tricks to defensive maneuvers, and so forth—again, all de-

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pend on the transfer of information between processor 60 and unit 42, and so forth.

In step 82, the user signals the processor 60 to activate the game to be played. In embodiments where the processor 60 executes on a mobile device, this is typically done via a graphical user interface. Although in some such embodiments, as well as those in which the processor executes on a dedicated device, such activation may involve the pressing of buttons, shaking or otherwise manipulating the device, and so forth. Indeed, in some embodiments, the game may be activated upon mounting of the skateboard 20, activation of the output device, mounting or tapping on the skateboard and so forth.

In step 84, the processor 60 executes initiation software ("game-playing software") that interprets tricks defining the game and the 3D virtual sound space and that drives the output device 62 to effect sounds embodying at least a portion that virtual sound space (e.g., in a vicinity of the actor represented by the skateboard 20 and/or its user) and/or the skateboard user's interaction with that virtual sound space. Initiating can include loading those rules and/or accompanying data (e.g., from memory, a central server or server, and so forth) and commanding the device 42 to initiate sensors.

In step 86, the game-playing software begins execution. This can include awaiting any user activation command indicating readiness to start the game (e.g., double-tapping on the skateboard 20). It can further include driving the output device 62 to effect a background environment of the sound space (or "soundscape") in which the game will be executed. Such a soundscape can include, by way of non-limiting example, backgrounds noises associated with a city, a ski slope, a battle field, a class room or other virtual environment in which the game is played.

In step 88, the game-playing software begins execution of the game, e.g., in response to a user activation command (again, for example, double-tapping on the skateboard). In the illustrated example of a voice-prompted game, this can include driving the audio output device to (i) include, along with the soundscape, an audio representation of a target (e.g., of a virtual player, character, obstacle, item of scenery, etc.) near to or far from the user in the virtual space and

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so forth).

By way of non-limiting example, in a "cloud server" game, the digital data processor 60 and game-playing software can generate simulated sounds of weather patterns (e.g., thunderstorms, sunny skies, etc.) in areas of the virtual sound space that correspond with regions of the country (or world) over which those weather patterns are occurring, e.g., based on measurements obtained by the digital data processor 60 in real-time (or otherwise) from a central server, a national weather service or otherwise. In such a game, the digital data processor can translate the user's actions on dashboard 20 into movement of a corresponding actor in the virtual sound space relative to those weather patterns, e.g., sounding thunder as the actor passes over the a stormy weather pattern in the virtual sound space, chirping birds as he/she passes over a sunny region, and so forth.

By way of further non-limiting example, in a multi-player racing challenge game, the digital data processor 60 and game-playing software can generate simulated sounds of other skateboarders, skiers, rollerbladers or other competitors that compete with the user within the virtual space. Movements of those other competitors can be based on measurements obtained from a central server, central score and/or other modes pertaining to movements by the operators of their respective skateboards. In such a game, the digital data processor can translate the user's actions on dashboard 20 into movement of a corresponding actor in the virtual sound space relative to the other players and, likewise, can translate those other player's actions on their respective systems into movement of their respective actors. Based on that, the digital data processor can drive the output device to simulate sounds of users passing, catching up to, being passed by, or taking other actions relative to the user in the sound space. This has the advantage, for example, of allowing multiple players to compete, even if they are not near one another physically.

Example

A sensor-based audio game using a skateboard as a controller

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pending on the rules of the game.

In step 94, the game-playing software drives the audio output device to provide audio feedback to the user regarding his/her performance, e.g., causing that device to sound upbeats, beeps, corrections of numerical ratings, etc., dependent on the user's success in performing the action, e.g., how well readings sensed by devices 40 and/or track 30 are judged by microprocessor 44 match continued issued in step 88.

In step 96, the game-playing software logs the user's performance, e.g., along with information gathered from unit 42 in step 82 and/or statistics regarding same, to a local score and/or to a central server or central data. An advantage of such logging is, for example, that it makes possible validating what games, sports or other endeavor the operator utilized on the skateboard (or other object) as well, for example, as the success of that endeavor.

In step 98, the game-playing software reads, for execution of the next step of the game and/or some execution in step 88, or exits, depending on rules of the game.

In some embodiments, the simulated sounds of other actors, skaters, skiers, etc., driven by the digital data processor 60 and, more particularly, game-playing software obtain an imaginary object whose position and/or actions are defined the rules and/or data that define (i) the game, sport, entertainment activity, training exercise or other endeavor for which the skateboard 20 is being used, and/or (ii) the virtual sound space in which that endeavor is exercised.

In other embodiments, those simulated sounds (or at least some of them) are based on positions, actions and/or other characteristics of real-world objects, e.g., other skateboarders (who, too, may be equipped with a system 10 according to each aspect of the invention), another person (whether or not on a skateboard), or any other object (e.g., a moving vehicle, an ocean wave, and

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```
TrickDetectionTrick; // detectTrick using sound detection, trick ;
if maximum score over all trickDetection > maximum score
recorded;
return false;
else return true; // end of the maximum scoring trick
end
trickDetectionTrick
```

With this framework in place, pseudocode representing an active game may look something like:

```
beginning trick detection loop using previous & time steps and de-
pending on state
state waitingForTrickStart;
allocate a counter/indicator to hold sensor
data needed to identify trick state becomes
detectionTrick
case detectionTrick:
add sensor input to trick detection buffer if
end-of-trick detected, state becomes
TrickCompleted
case TrickCompleted:
identify trick using deconvolution and
expectedTricks
update player object with status state becomes
waitingForTrickStart
```

Objects have position in the audio environment indicated by a characteristic sound of characteristic sounds. At each time step, this sound is modified based on the relative distance be- tween object and the player as well as the angle between the front of the player and the position of the object. These quantities are computed based on the sensor readings from the hardware em- bedded in the riot pad.

In each object there are also associated "Triggers"; certain classes of sensor data that ef-

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With a gyroscope and accelerometer mounted on skateboard inside a riot pad between the back, neck and the feet, it is possible to use a skateboard as a Bluetooth controller to con- trol an audio environment represented on a mobile device. Using these hardware elements, there is a general framework for developing gaming software based on the audio environment the user experiences.

The overall implementation of the game is a single large time event loop that continues until game termination. Each iteration through the loop corresponds to one set of values received from the sensors on the skateboard, an update of the objects in the virtual space, moves and ro- tates the environment to its new position relative to the player, update to the current score and a modification of the audio feedback. That is to say, for collection of data sent to the mobile device by the hardware the virtual space/audio environment is reconfigured and all objects in it have their state updated. Not all objects may move. Note that the player can also be seen as an object and be on the way move or rotate depending on the detected movements of the skateboard and the desired effect in the game.

Essential to any embodiment conceived of thus far is the interpretation of sensor data as tricks one can execute on a skateboard. So with each time step is associated an iteration of the trick detection algorithm. Trick detection consists of first identifying the start and ending of a trick. Tricks start with the board flat on the ground as easily determined from the accelerometer data, followed by a sharp increase in the angular velocity measured about at least one principle axis, as read from the gyroscope. The end of a trick is identified by another sharp change in an- gular velocity about one or more gyroscope axes, followed by the board being flat on the ground.

The game play specifies which trick or set of tricks are applicable at any point in time. Trick detection provides a score or accuracy of each trick based on the sensor data in the trick window, to pseudocode:

forward trick in trickDetectionTrick

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The initial level contains a small number of segments or waves. Each wave has a set of enemies and power-ups, e.g. objects, that the player must destroy and collect, respectively, in order to trigger the next wave.

In the first wave the player only encounters one type of object: the simplest type of enemy. The simplest of tricks kills it. It has only one unit of health and is susceptible to all forms of attack (i.e. any trick performed since will kill it). Six of these basic enemies comprise the first wave. Each enemy attacks one at a time and takes a linear path toward the position of the player. If the player is touched by the enemy the player loses one unit of health. Once the player successfully lands a trick while facing the enemy it dies and the next enemy approaches from a fixed relative position. After the player has defeated all six basic enemies wave one is finished.

Wave two is simply one item that when touched by the player restores his health by one unit. No trick is required to interact with this object; the required buffer data is simply alignment with the player and proximity. The player simply needs to turn and time the item as it moves linearly toward him. Failure to do so results in having to proceed to the third wave with all the damages acquired during the first wave.

The third and final wave is a boss. Just like the basic enemies of the first wave, all tricks successfully implemented while facing the boss decrease its health by one unit. However, differing from the basic enemies the boss has a total of three units of health and instead of advancing toward the player on a line the boss slowly spirals toward the player. When the player successfully attacks the boss, it retreats to a default distance and begins the spiral again. The boss also retreats position if the player fails to attack it and the boss touches the player reducing the player's health by one unit.

Pseudocode for this scenario might look something like this:

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Read the behavior and state of a given object. A trigger will typically be a combination of detected tricks and position relative to the player. For example, a trigger for a particular object might be a successfully landed kickflip with position in line with that of the player and within a certain distance. In this case if the player "sues" the object (i.e. causes the audio environment so that the front of the player object is turned toward the object with this trigger) and successfully lands a kickflip, the object's state would change in a prescribed way, such as losing a unit of health.

In pseudo-code, we have for example:

```
foreach object obj:
    update the position of the object, i.e., location and
    heading, based on current location, heading, and
    current linear and angular velocity

foreach object obj:
    if trigger T of obj evaluates to true:
        perform action associated with T for obj: update
        health of obj

foreach object obj:
    produce sound of T based on its location, health, and
    action
```

There is a data structure associated with each object. The set of objects specifies a special level of the game. The purpose of an early level of the game is to 1) familiarize the player with how to navigate space with a soundtrack using audio information as feedback, and 2) provide a basic framework of how the player can interact with various types of objects in his environment. What follows is a description of a simple level design from a game player's perspective that attempts to fulfill the above requirements while gently leading the player into the standard format of play.

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Conclusion

Described above are methods and systems meeting the objects and goals set forth. Those skilled in the art will appreciate that the embodiments shown in the drawings and described in the accompanying text are merely examples of the invention and that other embodiments, incorporating modifications and changes therein and including combinations of foregoing embodiments, fall within the scope of the invention.

Thus, for example, although the figures and corresponding text herein are principally directed to embodiments employing skateboards, the teachings herein may be utilized for identifying other items of motion of the user alone or in connection with other objects. An enumeration of example such objects is provided elsewhere herein.

In view of the foregoing, what is claimed is:

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```
data needed to define all the objects of level one
player_data = tick_data(player), min_bound, 0)
enemy_data = tick_data(enemy), min_bound, 0)
item_data = tick_data(item), min_bound, 0)
zone_data = tick_data(zone), min_bound, 0)

Data structure of level one
player = object(player_data, x=0, y=0, z, sample_1)
enemy = object(enemy_data, x=0, y=0, z, min_velocity,
sample_2)
item = object(item_data, x=0, y=0, z, max_velocity,
sample_3)
zone = object(zone_data, x=0, y=0, z, min_velocity, sample_4)

Data structure of level one
first_wave = wave(first_wave, 1, 2*pi/5)
second_wave = wave(second_wave, 1, 0)
third_wave = wave(third_wave, 1, 0)
```

Multi-Nodal System

A system 10 of the type shown in Figure 1 and described above can form one "node" in a larger system that includes, in addition to system 10, one or more other such systems. The respective microprocessors 44 and/or digital data processors 60 of those systems may communicate with one another on a peer-to-peer basis. Alternatively, or in addition, those systems may be coupled to a central node for logging of identified ticks, skateboard characteristics and/or associated information generated by the systems 10. Moreover, they may be coupled to a central server that facilitates the exchange of such ticks, characteristics and/or associated information between the nodes, e.g., in support of a social network, to facilitate competitions or otherwise, as discussed by way of example in incorporated-by-reference United States Patent Application Serial No. 61/571,161, filed August 3, 2010, United States Patent Application Serial No. 61/546,207, filed September 24, 2010, Reference is had in this particular regard and by way of non-limiting example, to the system 10' shown in Figure 4 of those respective applications and discussed in the accompanying text.

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physical space surrounding kinesthetic.

5. The system of claim 3, in which the digital data processor drives the audio output to effect the virtual sound space as a function of scripts, guidelines, programming or other rules (collectively, "rules") and/or data.

6. The system of claim 1, in which the digital data processor drives the audio output to effect a virtual sound space as a function of scripts, guidelines, programming or other rules (collectively, "rules") and/or data that define (a) define a game, sport, entertainment activity, training exercise or other endeavor for which the kinesthetic is being used, and/or (b) a virtual sound space in which at least one of players, characters, scenarios, scenery, an actor representing the kinesthetic operator, his/her game status, and kinesthetic movements (or other interactions) with the foregoing are represented to the operator by sounds.

7. The system of claim 5, in which the the operator effects those movements and interactions by moving and/or performing tricks (or feats) with that kinesthetic in the real and physical space surrounding kinesthetic.

8. The system of claim 1, in which the digital data processor drives the audio output to effect sounds defining at least a portion of the virtual sound space in a vicinity of an actor representing the kinesthetic under its operator.

9. The system of claim 8, in which the digital data processor drives the audio output to effect sounds reflecting the kinesthetic operator's (and/or the kinesthetic's) interaction with that virtual sound space.

10. The system of claim 1, in which the digital data processor drives the audio output to ef-

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In view of the foregoing, what we claim is:

1. A system for kinesthetic, comprising

A. a kinesthetic,

B. a sensing device that is attached or otherwise coupled to the kinesthetic and that measures a physical characteristic of it and/or of its environment,

C. an audio output device, and

D. a digital data processor that is communicatively coupled to the audio output device and the sensor, wherein the digital data processor drives the audio output device to effect one or more selected sounds and, further, monitors the sensing device to identify operator actions in response to those sounds and drives the audio output device to effect still further sounds based on those actions.

2. The system of claim 1, in which the digital data processor drives the audio output to effect a virtual sound space.

3. The system of claim 2, in which the digital data processor drives the audio output to effect the virtual sound space in which at least one of players, characters, obstacles, scenery, an actor representing the kinesthetic operator, his/her game status, and kinesthetic movements (or other interactions) with the foregoing are represented to the operator by sounds.

4. The system of claim 3, in which the the operator effects those movements and interactions by moving and/or performing tricks (or feats) with that kinesthetic in the real and

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19. The system of claim 1, in which one or more of the sensors are coupled to a user of the skateboard.

20. The system of claim 1, in which one or more of the sensors is gyroscope and/or other-wise measures rotation of the skateboard and/or the user thereof.

21. The system of claim 1, in which one or more of the sensors measure rotation around at least two axes of the skateboard.

22. The system of claim 1, in which one or more of the sensors measure rotation around at least three axes of the skateboard.

23. The system of claim 1, in which one or more of the sensors are any of accelerometers, magnetometers, global positioning sensors, and strain sensors.

24. The system of claim 1, in which one or more of the sensors are capable of measuring any of speed, acceleration, jerk, yaw, pitch, and roll of the skateboard and/or the user thereof.

25. The system of claim 1, wherein the data processor is coupled to the skateboard and/or the user thereof.

26. The system of claim 1, wherein the data processor comprises an address line, is reconfigurable to the skateboard.

27. The system of claim 1, wherein the data processor is integral to the skateboard.

28. The system of claim 1, wherein the data processor is any of a clip-on, wearable, pack-on, or carry-along device.

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for a voice.

11. The system of claim 10, in which the voice commands the skateboard operator to take a particular action.

12. The system of claim 1, in which the digital data processor drives the audio output device to effect sounds of approval or disapproval thereof.

13. The system of claim 1, in which the digital data processor drives the audio output device to simulate sounds of an object near or far from the operator and/or moving relative thereto.

14. The system of claim 1, in which the digital data processor determines whether the operator moved in a prescribed manner relative to the simulated object.

15. The system of claim 1, in which the digital data processor determines whether the operator performed a trick or other action on the skateboard that is interpreted as touching, cupping, shooting, freestyling, or taking some other action with respect to the simulated object.

16. The system of claim 1, in which the digital data processor drives the audio output device to simulate sounds of an object that is imaginary.

17. The system of claim 1, in which the digital data processor drives the audio output device to simulate sounds of an object whose position and/or actions are based on a real-world object.

18. The system of claim 17, where that real-world object is any of another skateboard, another person, or other object.

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29. The system of claim 1, in which the data processor is disposed remotely from the skateboard.	measures a physical characteristic of it and/or of its environment.
30. The system of claim 29, in which the data processor is comprised part a multifunction device.	C. an audio output device, and
31. The system of claim 30, in which the multifunction device is any of a cell phone, personal digital assistant, or other mobile device.	D. a digital data processor that is communicatively coupled to the audio output device and the sensor, wherein the digital data processor drives the audio output device to effect one or more selected sounds and, further, monitors the sensing device to identify operations or actions in response to those sounds and drives the audio output device to effect still further sounds based on those actions.
32. The system of claim 31, in which the digital data processor is coupled for wireless communications with one or more of the sensors.	32. The system of claim 30, in which the digital data processor drives the audio output to effect a virtual sound space.
33. The system of claim 32, wherein the digital data processor may of logs audio displays measurements received from the sensor.	38. The system of claim 37, in which the digital data processor drives the audio output to effect the virtual sound space in which at least one of players, characters, objects, scenery, an action representing the game/sport object operator, his/her game status, and game/sport object movements (or other interactions) with the foregoing are represented to the operator by sounds.
34. The system of claim 1, comprising two or more digital data processors.	39. The system of claim 38, in which the the operator effects those movements and interactions by moving and/or performing tricks (or feats) with that game/sport object in the real and physical space surrounding him/her.
35. The system of claim 34, wherein a first said digital data processor is coupled to the skateboard and wherein a second digital data processor is disposed remotely from the skateboard but is in communications coupling with any of the first said digital data processor and the one or more sensors.	40. The system of claim 38, in which the digital data processor drives the audio output to effect the virtual sound space as a function of scripts, guidelines, programming or other rules (collectively, "rules") and/or data.
36. A system for skateboarding, rollerboarding, skiing, rollerblading, or other game or sport and/or training thereof, comprising	41. The system of claim 36, in which the digital data processor drives the audio output to effect a virtual sound space as a function of scripts, guidelines, programming or other
A. any of a skateboard, surfboard, snowboard, ski, rollerblade boot, or other apparatus for game or sport (collectively, "game/sport object");	
B. a sensing device that is attached or otherwise coupled to the game/sport object and that	

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to simulate sounds of an object near or far from the operator and/or moving relative thereto.

49. The system of claim 36, in which the digital data processor determines whether the operator moved in a prescribed manner relative to the simulated object.

50. The system of claim 36, in which the digital data processor determines whether the operator performed a task or other action on the game/sport object that is interpreted as touching, capturing, shooting, fleeing, or taking some other action with respect to the simulated object.

51. The system of claim 36, in which the digital data processor drives the audio output device simulate sounds of an object that is imaginary.

52. The system of claim 36, in which the digital data processor drives the audio output device simulate sounds of an object whose position and/or actions are based on a real-world object.

53. The system of claim 52, where that real-world object is any of another game/sport object, another person, or other object.

54. The system of claim 36, in which one or more of the sensors are coupled to a user of the game/sport object.

55. The system of claim 36, in which one or more of the sensors is gyroscopic and/or otherwise measures rotation of the game/sport object and/or the user thereof.

56. The system of claim 36, in which one or more of the sensors measure rotation around at

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rates (collectively, "rates") and/or data that define a game, sport, entertainment activity, training exercise or other endeavor for which the game/sport object is being used, and/or (b) a virtual sound space in which at least one of players, characters, objects, scenery, an actor representing the game/sport object operator, his/her game status, and game/sport object movements (or other interactions) with the foregoing are represented to the operator by sounds.

42. The system of claim 40, in which the the operator effects three main events and interactions by moving and/or performing tasks (or both) with that game/sport object in the real and physical space surrounding him/her.

43. The system of claim 36, in which the digital data processor drives the audio output to effect sounds defining at least a portion of the virtual sound space in a vicinity of an actor representing the game/sport object and/or its operator.

44. The system of claim 43, in which the digital data processor drives the audio output to effect sounds reflecting the game/sport object operator's (and/or the game/sport object's) interaction with that virtual sound space.

45. The system of claim 36, in which the digital data processor drives the audio output to effect a voice.

46. The system of claim 45, in which the voice commands the game/sport object operator to take a particular action.

47. The system of claim 36, in which the digital data processor drives the audio output device to effect sounds of approval/disapproval or degrees thereof.

48. The system of claim 36, in which the digital data processor drives the audio output device

- | | Audio Provision | Audio Provision | |
|-----|---|-----------------|---|
| 57. | least two axes of the game/sport object. | 66. | The system of claim 65, in which the multifunction device is any of a cell phone, personal digital assistant, or other mobile device. |
| 58. | The system of claim 56, in which one or more of the sensors measure rotation around at least three axes of the game/sport object. | 67. | The system of claim 66, in which the digital data processor is coupled to wireless communications with one or more of the sensors. |
| 59. | The system of claim 56, in which one or more of the sensors are any of accelerometers, magnetometers, global positioning sensors, and strain sensors. | 68. | The system of claim 67, wherein the digital data processor any of logs and/or displays measurements received from the sensor. |
| 60. | The system of claim 56, in which one or more of the sensors are capable of measuring any of speed, acceleration, jerk, yaw, pitch, and roll of the game/sport object and/or the user thereof. | 69. | The system of claim 56, comprising two or more digital data processors. |
| 61. | The system of claim 56, wherein the data processor is coupled to the game/sport object and/or the user thereof. | 70. | The system of claim 69, wherein a first and digital data processor is coupled to the game/sport object and wherein a second digital data processor is disposed remotely from the game/sport object but is in communications coupling with any of the first and digital data processor and the one or more sensors. |
| 62. | The system of claim 56, wherein the data processor comprises an add-on (i.e., is retrofitted) to the game/sport object. | 71. | A system for game, sports, entertainment or other motion, comprising |
| 63. | The system of claim 56, wherein the data processor is integrated to the game/sport object. | A. | an object, |
| 64. | The system of claim 56, wherein the data processor is any of a clip-on, wearable, pocketable, or carry-along device. | B. | a sensing device that is attached or otherwise coupled to the object and that measures a physical characteristic of it and/or of its environment, |
| 65. | The system of claim 56, wherein the data processor is disposed remotely from the game/sport object. | C. | an audio output device, and |
| 66. | The system of claim 64, in which the data processor is comprises a multifunction device. | D. | a digital data processor that is communicatively coupled to the audio output device and the sensor, wherein the digital data processor drives the audio output device to effect one or more selected sounds and, further, causes the sensing device to identify, capture, or files in response to those sounds and drives the audio output device to effect still further |

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ed space surrounding him/her.	sounds based on those actions.
78. The system of claim 71, in which the digital data processor drives the audio output to effect sounds defining at least a portion of the virtual sound space in a vicinity of an actor representing the object and/or its operator.	73. The system of claim 71, in which the digital data processor drives the audio output to effect a virtual sound space.
79. The system of claim 78, in which the digital data processor drives the audio output to effect sounds reflecting the object operator's (and/or the object's) interaction with the virtual sound space.	74. The system of claim 73, in which the digital data processor drives the audio output to effect the virtual sound space in which at least one of players, characters, obstacles, scenery, an actor representing the object operator, his/her game status, and object movements (or other interactions) with the foregoing are represented to the operator by sounds.
80. The system of claim 71, in which the digital data processor drives the audio output to effect a voice.	75. The system of claim 73, in which the digital data processor drives the audio output to effect the virtual sound space as a function of scripts, guidelines, programming or other rules (collectively, "rules") and/or data.
81. The system of claim 80, in which the voice commands the object operator to take a particular action.	76. The system of claim 71, in which the digital data processor drives the audio output to effect a virtual sound space as a function of scripts, guidelines, programming or other rules (collectively, "rules") and/or data that define (a) define a game, sport, entertainment activity, training exercise or other endeavor in which the object is being used, and/or (b) a virtual sound space in which at least one of players, characters, obstacles, scenery, an actor representing the object operator, his/her game status, and object movements (or other interactions) with the foregoing are represented to the operator by sounds.
82. The system of claim 71, in which the digital data processor drives the audio output device to effect sounds of approach/dissipation or degrees thereof.	77. The system of claim 75, in which the operator effects those movements and interactions by moving and/or performing tracks (or tasks) with that object in the real and physical space surrounding him/her.
83. The system of claim 71, in which the digital data processor drives the audio output device to simulate sounds of an object near or far from the operator and/or moving relative thereto.	
84. The system of claim 71, in which the digital data processor determines whether the operator moved in a prescribed manner relative to the simulated object.	
85. The system of claim 71, in which the digital data processor determines whether the operator performed a trick or other action on the object that is interpreted as teaching, coaching,	

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ing, shooting, firing, or taking some other action with respect to the simulated object.

86. The system of claim 71, in which the digital data processor drives the audio output device simulate sounds of an object that is imaginary.

87. The system of claim 71, in which the digital data processor drives the audio output device simulate sounds of an object whose position and/or actions are based on a real-world object.

88. The system of claim 87, where that real-world object is any of another object, another person, or other object.

89. The system of claim 71, in which one or more of the sensors are coupled to a user of the object.

90. The system of claim 71, in which one or more of the sensors is gyroscope and/or other, whose measures rotation of the object and/or the user thereof.

91. The system of claim 71, in which one or more of the sensors measure rotation around at least two axes of the object.

92. The system of claim 71, in which one or more of the sensors measure rotation around at least three axes of the object.

93. The system of claim 71, in which one or more of the sensors are any of accelerometers, magnetometers, global positioning sensors, and other sensors.

94. The system of claim 71, in which one or more of the sensors are capable of measuring

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any of speed, acceleration, jerk, yaw, pitch, and roll of the object and/or the user thereof.

95. The system of claim 71, wherein the data processor is coupled to the object and/or the user thereof.

96. The system of claim 71, wherein the data processor comprises an address (i.e., is interfaced) to the object.

97. The system of claim 71, wherein the data processor is integrated to the object.

98. The system of claim 71, wherein the data processor is any of a clip-on, wearable, pocketable, or carry-along device.

99. The system of claim 71, in which the data processor is disposed remotely from the object.

100. The system of claim 99, in which the data processor is comprises part a modification device.

101. The system of claim 100, in which the modification device is any of a cell phone, personal digital assistant, or other mobile device.

102. The system of claim 101, in which the digital data processor is coupled for wireless communications with one or more of the sensors.

103. The system of claim 101, wherein the digital data processor any of logs and/or displays measurements received from the sensor.

104. The system of claim 71, comprising two or more digital data processors.

Abstract

Devices, systems, and methods according to one such aspect of the invention comprises (i) a sensing device that is attached (or otherwise coupled) to a skateboard and that measures a physical characteristic of it within of its environment, (ii) an audio output device, and (iii) a digital data processor that is communicatively coupled to the audio output device and the sensor. The digital data processor drives the audio output device to effect one or more selected sounds (e.g., to prompt the user to perform a selected action). The digital data processor, further, and monitors the sensing device to identify user actions in response to those sounds and drives the audio output device to effect still further sounds based on those actions. The digital data processor drives the audio output to effect sounds as a function of script, guidelines, programming or other rules (collectively, "rules") and/or data that (a) define the game, sport, entertainment activity, training exercise or other endeavor for which the skateboard is being used, and/or (b) a virtual sound space in which that endeavor is executed—i.e., an auditory space, preferably, of three-dimensions, in which everything from other players, to characters, to obstacles or scenery, to the actor representing the skateboard operator, his/her game status, the skateboard movements (or other interactions) with the foregoing are represented to the operator by sounds, yet, where, the user affects those movements and interactions by moving and/or performing tricks (or fees) with that skateboard in the real and physical space surrounding himself.

105. The system of claim 104, wherein a first said digital data processor is coupled to the object and wherein a second digital data processor is disposed remotely from the object but is in communications coupling with any of the first said digital data processor and the one or more sensors.

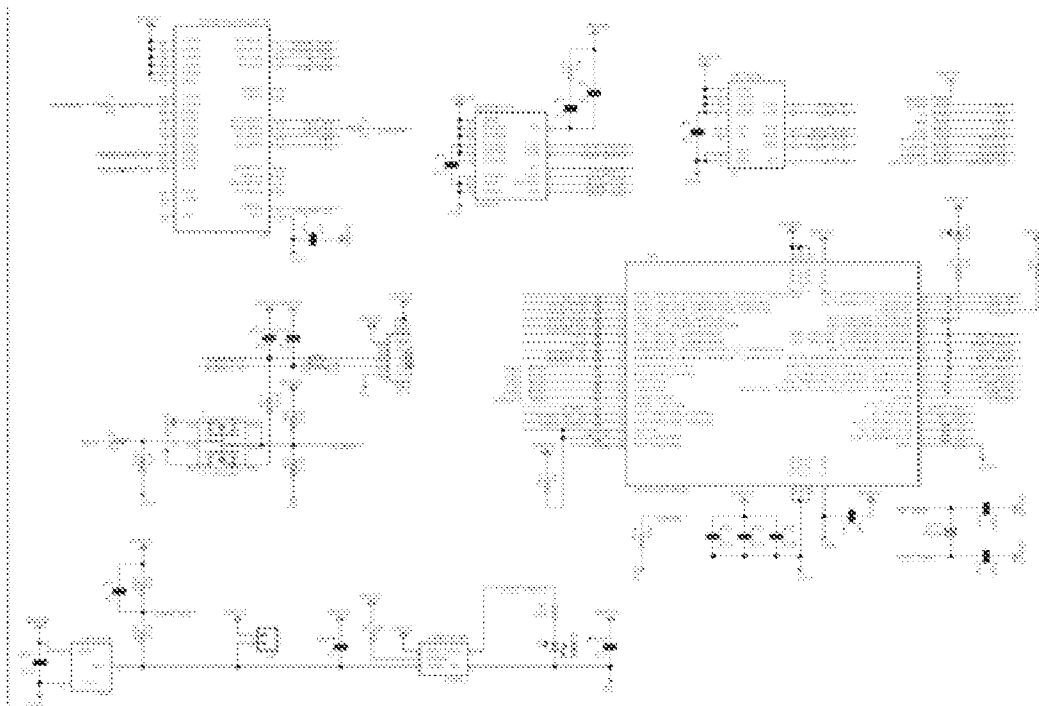
106. A method of operation of the systems of any of claims 1-104.

107. A skateboard of the system of claim 1-35.

108. A skateboard, skateboard, skateboard, skateboard, skateboard, or other apparatus for game or sport (collectively, "game/sport object") of any of claims 36-71.

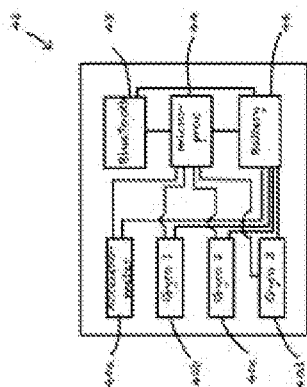
109. An object of any of claims 71-104.

Audio Processor

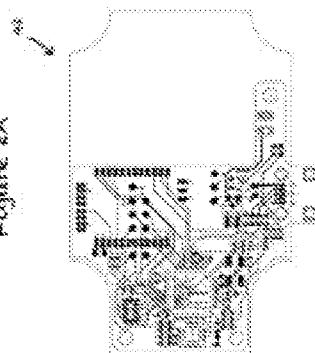


Audio Processor

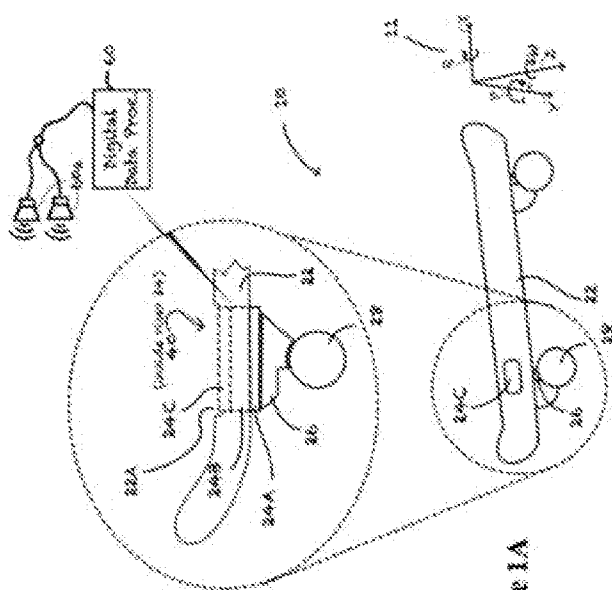
Appendix 1



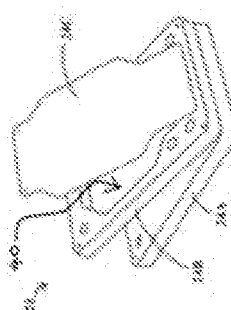
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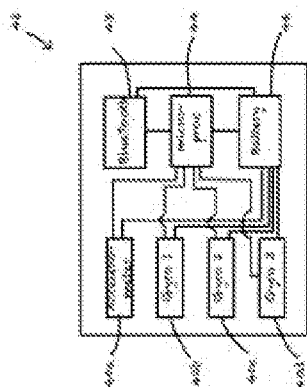
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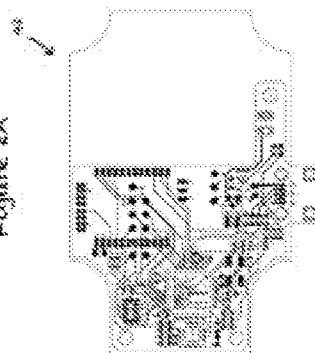
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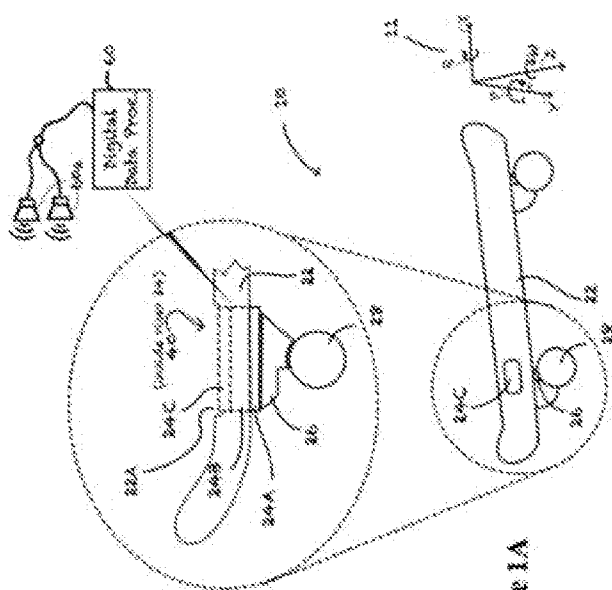
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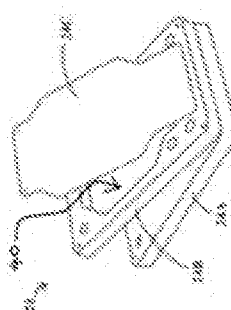
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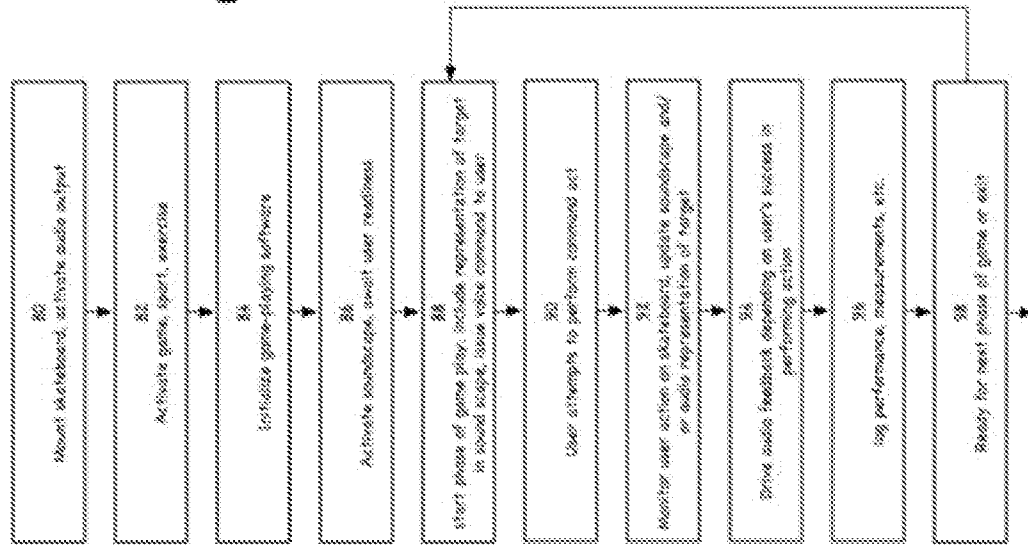


Figure 4

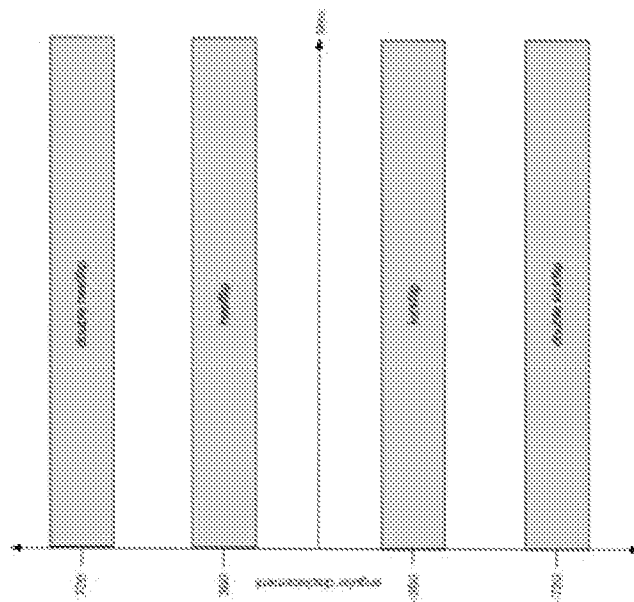


Figure 3

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Appendix III

Copy of co-pending, commonly assigned United States Patent Application Serial No.
....., filed this same day herewith, entitled "Digital Data Processing Systems And Meth-
ods For Skateboarding And Other Activities Of Motion."

Trick

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PROVISIONAL PATENT APPLICATION

FOR

SIGNATURE-BASED TRICK DETERMINATION SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER ACTIVITIES OF MOTION

Inventors:

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Jason Choumouchet,
Jon Williams,
Matt Garcia

Reference to Related Applications

This claims the benefit of filing of co-pending, commonly assigned United States Patent Application Serial No. 61/573,474, filed August 3, 2010, United States Patent Application Serial No. 61/771,161, filed August 3, 2010, and United States Patent Application Serial No. 61/966,307, filed September 24, 2010, all entitled "DIGITAL DATA PROCESSING SYSTEMS AND METHODS FOR SKATEBOARDING AND OTHER SOCIAL SPORTING ACTIVITIES," the teachings of all of which are incorporated by reference herein.

This application is related to co-pending, commonly assigned United States Patent Application Serial No. _____, filed this same day herewith, entitled "Devices, Systems, And Methods for Games, Sports, Entertainment And Other Activities Of Engagement," the teachings of which are incorporated herein by reference.

Background of the Invention

The invention relates to improved systems and methods for skateboarding and other activities of motion-referred to, here, for sake of simplicity and without loss of generality as "sports," "sporting activities," and the like (regardless of whether such activities are so known in conventional parlance) and practitioners of which are referred to, here, as "sports enthusiasts," and the like. The invention has application in facilitating training of, competition and/or among and like-minded enthusiasts.

Sports enthusiasts like to learn and perform feats. Skateboarders, for example, practice tricks over and over, in order to learn new ones and to perfect old ones. To gauge their progress, skateboarders rely on "fict." guesswork or, better usually, the opinions of others.

Regardless, skateboarders—like other sports enthusiasts—are eager to show their progress and are always in search of new venues to do so. They may train or show their tricks in skateparks but, more often, they do so on sidewalks, in driveways, playgrounds, and other spaces that have not

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Summary of the Invention

The foregoing are among the objects attained by the invention, which provides in some aspects improved devices, systems and methods for skateboarding (and other sporting activities) that monitor motion of a skateboard to identify tricks (i.e.,) performed with, by or on it by a user.

A system according to one aspect of the invention includes (i) a sensing device that is attached (or otherwise coupled) to the skateboard and that measures a physical characteristic of it, and (ii) a data processor that identifies the feet or trick (or other action) performed by or on the skateboard based, at least in part, on correspondence between physical characteristics of motion and/or of the skateboard's environment measured by the sensing device(s) and a signature associated with each of one or more possible tricks.

Further aspects of the invention provide a system, e.g., as described above, in which the sensing device—which may be coupled to the operator and particularly, for example, his/her shoes, etc., instead or in addition to being coupled to the skateboard—is gyroscopic and/or otherwise measures rotation of the skateboard and/or its operator. This can include, for example, gyroscopic sensors that measure such rotation, preferably along at least two—used, still more preferably, along at least three—of x-, y- and z-axes. According to other aspects of the invention, other sensors suitable for detecting rotational and/or other physical characteristics of the skateboard (and/or operator) are used instead or in addition to gyroscopic sensors. These include, by way of non-limiting example, accelerometers, magnetometers, global positioning sensors, strain sensors, or other sensors capable of indicating speed, acceleration, jerk, yaw, pitch, roll, or other physical characteristics of the skateboard, its user and/or the its environment.

Further aspects of the invention provide a system, e.g., as described above, in which the data processor is coupled to the skateboard and/or operator, for example, in the form of an add-on or integral module (e.g., in the case of the skateboard) or a clip-on, wearable, pocketable, or carry-along (e.g., in the case of a operator).

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been designed for skateboarding. Unfortunately, they can typically only display their feats to fellow enthusiasts who are in the same locale at the same time. For example, a skateboarder who has perfected a multiple variational flip is usually limited to proving his/her prowess to friends at the local park. One of them might say or “trick” news of the feat to others, but that is likely to be dismissed as unbelievable, particularly, if the feat is extraordinary. Some of that disbelief might be dispelled by posting of a video of the feat, but even that may be subject to skepticism.

An object of the invention is to provide improved devices, systems and methods for skateboarding or other activities of motion (here, again, “sporting activities.”)

A related object is to provide such improved devices, systems and methods as facilitate training in basic and advanced feats (or “tricks.”).

A further related object of the invention is to provide improved such devices, systems and methods as can be used to publicize feats of skateboarders, other sports enthusiasts and others.

A further related object of the invention is to provide improved such devices, systems and methods as can be used to facilitate interaction and/or competition among remotely disposed skateboarders, other social sports enthusiasts and others.

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performed by the operator.

In other aspects, the invention provides a system as described above in which the sensing device is attached or otherwise coupled to a wristband, watchband, bracelet, shoe, ski boot, surfboard or other object (and/or the operator thereof) in lieu of a skateboard (and/or operator thereof).

Related aspects of the invention provide a system, for example, as described above, in which the data processor—in addition to or instead of logging and/or displaying identified tricks and/or the measured characteristics—transmits them to a server digital data processor ("server"), for example, via e-mail and/or other logic provided in the mobile device of which the data processor forms a part and/or via a modem, network interface card or other circuitry, e.g., in instances where the data processor is a stand-alone device, or otherwise. Such transmission can be via Bluetooth, WiFi, cellular, infrared or other wireless or wired transmission medium, or otherwise.

Further related aspects of the invention provide a system, e.g., as described above, wherein the data processor transmits the identified tricks and/or measured characteristics to the server, e.g., along with still images, video images, location and/or other information associated with the trick, measurements, skateboard, its environment, the user or otherwise. This associated information can be generated by the data processor, a mobile (or other) device of which it forms a part, or otherwise. The location information may be, for example, GPS data and/or it may be identifying information, e.g., phone number, ESN, serial number, or so forth.

Further related aspects of the invention provide a system, for example, as described above, in which the server logs the identified tricks and/or measured characteristics, along with still/video images, location information and/or other information, and makes them available for access by the aforementioned mobile device and/or by other data processing apparatus, such as, mobile devices, data processors, portable computers, desktop computers, and so forth, of other enthusiasts—including other users (or "operators") of skateboards, watchbands, surfboards, rollerblade boots, or other objects (and/or the operators thereof).

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Still further related aspects of the invention provide a system, e.g., as described above, in which the data processor is disposed remotely from the skateboard, yet, coupled for communications with it (and, more particularly, for example, the sensing device). Such a "remote" data processor can be a dedicated device or it can be part of a multifunction device, e.g., as in the case of a data processor that is embedded in a cell phone, personal digital assistant, or other mobile device (collectively, "mobile device"), that performs other functions, e.g., in addition to identifying tricks (or other actions) by the skateboard and/or operator.

Further aspects of the invention provide a system, e.g., as described above, in which the sensing device communicates with such a remote data processor wirelessly, e.g., via Bluetooth, WiFi, cellular, infrared or other wireless or wired transmission medium, or otherwise. The data processor can optionally log and/or display measurements received from the sensors), e.g., in addition to tricks identified by it based on those measurements. An advantage of such logging is, for example, that it makes possible validating what tricks and other actions an operator indeed performed on the skateboard (or other object).

Yet still other aspects of the invention provide a system, e.g., as described above, that includes two (or more) data processors, e.g., one that is coupled to the skateboard and/or operator, and one that is disposed remotely. The two (or more) data processors can be coupled for communications via wire and/or wirelessly. They may, moreover, share and/or divide up one or more of the tasks attributed to the "data processor" or "server" in this summary and elsewhere herein. Thus, for example, according to one such aspect of the invention, a data processor that is coupled to the skateboard performs trick identifications based on measurements made by the sensing device and routes these identifications to the remote digital data processor, along with underlying sensor readings, for further processing by it.

Further aspects of the invention provide a system, e.g., as described above, in which the data processor includes and/or is coupled to a table (or other store) that enumerates known tricks (or other actions) and corresponding signatures, and in which the data processor compares measurements received from the sensors) against that table (or store) to identify tricks (or other actions

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trick to be performed by the first aficionado operator and/or of the other enthusiasts, and that determines if those tricks were completed successfully. Related aspects allow such an operator or other enthusiast to select a trick to be performed and that determines if the trick is completed successfully. Related aspects provide such a system that determines a winner or winners such as operator and other enthusiasts who perform such specified or selected tricks.

Still yet further aspects of the invention provide a system, for example, as described above, in which the server, data processors, mobile devices, portable computer, desktop computers and/or other data processing apparatus of the first aficionado operator and/or of the other enthusiasts facilitate a challenge by one of those other enthusiasts, e.g., to surpass some or all of the identified tricks and/or measured characteristics of the first aficionado operator, and/or vice versa—e.g., to engage in a competition.

Other aspects of the invention provide a system, as described above, for example, that generates an audio output based on the identified tricks and/or measured characteristics of the skateboard, surfboard, snowboard, ski, rollerblade boot, or other object (and/or the user thereof).

Related aspects of the invention provide a system, as described above, for example, in which the data processor is coupled to an audio output device and that generates an signal for sounding thereon based on a prompt by the user, identification of a trick, and/or upon detection of selected data measured by the sensing device. In related aspect, the data processor manipulates the audio output based on further prompts by the user, further trick identification and/or further measured characteristics.

Other aspects of the invention provide a system, as described above, for example, in which the audio output device is disposed remotely from the data processor.

Other aspects of the invention provide a system, for example, as described above, in which the data processor executes applications software providing one or more of the functions that are described above to the mobile device.

Related aspects of the invention provide sensing devices as described above, e.g., for coupling to

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Still further related aspects of the invention provide a system, for example, as described above, in which the server makes the identified tricks and/or measured characteristics, still/video images, location information and/or other information of the first aficionado operator available for access via an addressable site on the Internet and/or via a social networking web site.

Yet still further aspects of the invention provide a system, for example, as described above, in which the server, data processors, mobile devices, portable computer, desktop computers and/or other data processing apparatus of the first aficionado operator and/or of the other enthusiasts facilitate a challenge by one of those other enthusiasts, e.g., to surpass some or all of the identified tricks and/or measured characteristics of the first aficionado operator, and/or vice versa—e.g., to engage in a competition.

Related aspects of the invention provide a system, for example, as described above, in which the data processor of a competing enthusiast identifies tricks and/or collects like information measured by a sensing device attached to a skateboard, surfboard, rollerblade boot, or other object operated by that enthusiast, and transmits data to the server, e.g., along with still images, video images, location and/or other information collected as above.

Still yet further related aspects of the invention provide a system, for example, as described above, in which the server, data processors, mobile devices, portable computer, desktop computers and/or other data processing apparatus of the first aficionado operator and/or of the other enthusiasts facilitate communications to operators when their identified tricks and/or measured characteristics have been exceeded by other enthusiast operators.

Still yet further aspects of the invention provide a system, for example, as described above, in which the server, data processors, mobile devices, portable computer, desktop computers and/or other data processing apparatus of the first aficionado operator and/or of the other enthusiasts facilitate a live competition among operators.

Other aspects of the invention provide a system, as described above, for example, that specifies a

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Brief of Illustrated Embodiments

A more complete understanding of the invention may be attained by reference to the drawings, in which:

Figures 1A-1B depict a system according to the invention for identifying tricks (or flaws) performed on an skateboard (or other object) and for generating, transmitting, and analyzing data relating to other characteristics of the skateboard;

Figures 2A-2B schematically depicts a sensing device according to the invention for identifying tricks, generating and transmitting data for use in the system of Figure 1;

Figure 3 depicts an aspect of trick identification in a system according to the invention; and

Figure 4 depicts a table used in trick identification in other systems according to the invention.

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a dashboard, surfboard, rollerblade boot, or other object (and/or the operator thereof) and/or for communication with a data processor as described above;

Related aspects of the invention provide a data processor and/or device incorporating some as described above;

Related aspects of the invention provide a server, laptop, desktop or other data processor as described above;

Related aspects of the invention provide methods of operating one or more of the a sensing device, data processors, mobile device, laptop, desktop and/or server as described above.

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in search of new venues to do so. They may train or show their tricks in skateparks but, more often, they do so on sidewalks, in driveways, playgrounds, and other spaces that have not been designed for skateboarding.

Unfortunately, they can typically only display their feats to fellow enthusiasts who are in the same locale at the same time. For example, a skateboarder who has perfected a multiple varied foot flip, is usually limited to proving his/her prowess to friends at the local hangout. One of them might text or "tweet" news of the feat to others, but that is likely to be dismissed as unbelievable, particularly if the feat is extraordinary. Some of that disbelief might be dispelled by posting of a video of the feat, but even that may be subject to skepticism.

The illustrated embodiment leverages different and unique characteristics of skateboarding and other activities of motion to identify feats and/or to otherwise generate, analyze and/or exchange information regarding those feats and/or other characteristics of the equipment and the environment in which they are performed.

Skateboarding (Figure 1A)

Figure 1A depicts a system 10 according to one practice of the invention for identifying tricks performed on a skateboard 20 and/or for otherwise generating, transmitting, and analyzing data pertaining to motion of the skateboard. Other embodiments employing the teachings hereof and within the ken of those of ordinary skill in the art may be utilized for identifying other kinds of motion of the user alone or in connection with other objects. Non-limiting examples of other such objects (and feats of motion) include, inter alia, golf clubs (swing profile), a person diving off a springboard (rotation rate), or a dog on an agility course (path and speed through weave sticks).

The illustrated system includes one or more sensing devices 40 (also referred to here as measurement devices) that are attached to a skateboard 20 and that are in communications coupling with one or more digital data processors, here, in this drawing, represented by digital data processor

Trick

Detailed Description of the Illustrated Embodiment

Despite the multitude of advanced technologies found in the components of modern skateboards, very little is dedicated to measuring the tricks that skateboarders perform. The old adage due to Lord Kelvin, "if you can't measure it, you can't improve it" applies to skateboarders.

Systems according to the invention comprise hardware and/or software that identifies and measures the feats (e.g., tricks) that skateboarders and enthusiasts of other sporting and non-sporting activities perform. For sake of convenience, and without loss of generality, such systems will be described in connection with skateboarding in much of the discussion below, though, it will be appreciated that it can be used in connection other activities of motion (here, "sporting" activities) as well.

As will be evident below, there are several uses of systems according to the invention. They can be used for training skateboarders on new tricks, as well as perfecting old ones. They can be used, as well to "score" or "rate" particular tricks—whether to test the effectiveness of training or as part of a competition.

Unlike the prior art, where a skateboarder's success in mastering a new trick or in proving competency in an old one is based on the opinion of others, systems according to the invention provide unbiased, objective measures. In addition, they provide measures (e.g., trajectory and motion of the skateboard through space) that can be quantified, visualized, replayed, and compared any number of times, e.g., on a computer or smartphone and/or over the Internet.

In addition to promoting training and competition, systems according to the invention help to form and engage a community of skaters (or others) at local or larger region-wide, around the world. Such systems can also use geolocation to track best scores at a given location, e.g., over a period of time, so that the winner can be declared the "king of the park."

As noted above, skateboarders, as well as others are eager to share their progress and are always

Track

angle.

The sensing devices 40 can comprise conventional sensors of the type for measuring linear and/or rotational position and/or motion known in the art, as adapted to accord with the teachings hereof. Thus, for example, the devices 40 may comprise GPS sensors, accelerometers, gyroscopes, magnetometers, temperature sensors, strain sensors, optical sensors, acoustic sensors, RFID (radio frequency identification) and so forth embodied in microelectromechanical systems (MEMS) or otherwise, and all as adapted to accord with the teachings hereof. For example, in some embodiments, optical sensors are utilized alone—or, for example, with LED lasers or other light-emitting devices—to facilitate detecting when the skateboard 20 is engaged in a “grind.” By way of further example, in some embodiments, an RFID receiver chip attached to the skateboard 20 can be used in conjunction with an RFID transmitter chip attached to the user's shoes (or elsewhere) to facilitate (i) identification and/or orientation of the user.

Placement

The sensing devices 40 can be coupled to any portion of the skateboard 20—though, in some embodiments, placement is dictated by several factors related to standard use cases: where on the board will the sensing devices experience the least damage, what is least intrusive to the skateboarding experience, and what is most aesthetically pleasing.

Significantly, placement is also dictated by location(s) that facilitate measurement by sensing devices 40 (e.g., accelerometers) that are best interpreted by data processor 60 to identify tricks performed on a skateboard (and/or to otherwise provide for the meaningful generation of data pertaining to the skateboard). In this regard, placement can be made to accord with an analytic solution to the three coupled differential equations for rigid body motion known as Euler's equations. Precise placement in this regard is not critical, however, since the set of motions that constitute skateboard tricks is sufficiently limited to admit corner methods of distinction (and, hence, allowing more weight to be given to the other placement factors).

Track

60.

Sensing Devices

The sensing devices 40 measure position, motion and/or other physical characteristics of the skateboard 20 and/or its environment. Position measurements can include absolute or relative position (e.g., as determined to accord with GPS satellite signals or otherwise), linearly or rotationally—including, by way of non-limiting example, location, orientation and/or altitude. Referring to the associated axes 11 shown on Figure 1A, motion measurements can include linear motion and/or rotation motion, including, for example:

- 1) roll (denoted “R”, in the drawing) - total angular displacement about the longest principle axis X of the skateboard given relative positioning of the sensors to the skateboard;
- 2) pitch P - total angular displacement about the second principle axis Y of the skateboard parallel to the ground when the skateboard is at rest on its wheels;
- 3) yaw (“W”) - total angular displacement about the principle axis Z of the skateboard perpendicular to the ground when the skateboard is at rest on its wheels;
- 4) acceleration - acceleration detected along the longest axis X of the skateboard;
- 5) initial pitch - the sign of the pitch P detected nearest the start point of the data window. In the drawing, that sign is indicated by “+” and “-” signs adjacent ends of the curved arrows denoting the pitch P.

Other motion measurements can include speed, jerk, among others. Other characteristics of the skateboard can include orientation of the operator/user, weight of the operator/user and/or other forces and strains on the skateboard, temperature and wind speed, all by way of non-limiting ex-

Track

vices 40, uploading of data and/or control software, and/or downloading of data.

A cover pad 24 that achieves the foregoing is illustrated in Figure 1B. This pad 24, which is generally of a "clanshell" design, includes a base portion 24A, a body portion 24B, and a cover 24C. These portions may be hinged to one another, as shown in the drawing, though this is not the case of all embodiments. And, while the cover 24C is preferably removable from the other portions 24A, 24B, these other portions may, indeed, be formed as one.

In the illustrated embodiment, the pad 24 is mounted in a cavity 22A of the deck 22 such that the cover 24C is accessible from the top of the deck (i.e., the side opposite the deck from the track 26 and wheels 28) and such that the base 24A is accessible—and, preferably, stands proud from—the bottom of the deck 22. The latter permits, in some embodiments, mounting of the track 26 to the base 24A and, in some embodiments, exposes a port (not shown here), e.g., a charging port and/or data port, for access by the operator when the board 20 is not in use.

Consistent with the discussion above, the pad 24 and, particularly, the body portion 24B thereof are disposed within deck 22 such that sensing devices 40 mounted within the pad 24 are disposed asymmetrically along the longest principle axis X of the skateboard, while being approximately symmetrically disposed along the remaining two principle axes Y and Z, as shown. Though shown in an open configuration in the drawing, during normal use of the skateboard 20, the body of spacer 24 is disposed in recess 22A and is closed.

Portions 24A, 24B may be formed of metal, plastic, wood, carbon fiber or other material of suitable durability, e.g., for permanent or semi-permanent affixation in deck 22 and for mounting of track 26, as shown in Figure 1A. Cover 24C is preferably formed of plastic, wood or other material sufficiently flexible to withstand pounding, rubbing or other contact by the the operator, yet which does not interfere with wireless communications, e.g., to/from sensing devices 40 disposed within the pad 24. The various portions 24A, ..., 24C preferably includes seals, e.g., O-rings, or the like, that prevent water, dirt and other contaminants from entering the body and, thereby,

Track

By placing the sensing devices on the skateboard asymmetrically along its longest principle axis and approximately symmetrically along the remaining two principle axes one can sense the centrifugal acceleration in the rotating frame accurately experienced when the skateboard rotates about a non-principle axis during a trick. This hinges on how limited the class of rigid body motions that constitute tricks is: any trick that does not rotate solely about a principle axis necessarily has large angular velocity in roll and registers non-zero angular velocity about all three principle axes for the duration of a trick. In the standard language of skateboarding the first of these characteristics is tantamount to saying that if two tricks that rotate about a single principle axis are combined, one of them will be a kickflip or a heelflip.

This partially symmetric placement of sensors can be used to detect centrifugal accelerations of the skateboard 20 (or other object) along its longest principle axis, which in turn is useful in developing a myriad of coarse yet meaningful classifications of rigid body motion. The outlined sensor placement criteria has broad application in many fields outside of skateboarding. Indeed, any activity of motion involving a rigid body that has a distinctly long principle axis would benefit from this scheme in tracking and classifying rigid body motion.

Base Pad (Figure 1B)

Referring to Figure 1B, the sensing devices 40 can be embedded, mounted or otherwise fixed to the tracks 26, which connect wheels 28 to deck 22. Alternatively, the devices 40 can be affixed to a surface of the deck 22 or elsewhere on the skateboard.

Regardless, the sensing devices are preferably mounted to the skateboard 20 in a manner that achieves the desired placement while, at the same time, (i) protecting the devices 40 from damage as the skateboard is stepped upon, gripped and/or slammed during use (e.g., jumped upon by the user, gripped against wall rails, slammed against curbs, and so forth); (ii) permitting access to batteries, sensors and associated logic of the sensing devices 40; (iii) permitting transmission of wireless signals to/from the sensing devices, e.g., without requiring signal penetration through the track 26, which is typically metal; and/or (iv) permitting recharging of batteries for the de-

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for example, via Bluetooth, WiFi, cellular, infrared, or other wireless or wired transmission medium, or otherwise) with the sensing devices 40 and/or another data processor (e.g., an embedded microprocessor) that is itself in communications coupling with those devices 40.

Sensing Device Packaging (Figure 2)

As noted above in connection with Figure 1, the sensing devices 40 can comprise conventional sensors of the type known in the art for measuring position, motion and/or other physical characteristics of the skateboard 20 and/or its environment, as adapted in accord with the teachings hereof. Thus, for example, the devices 40 may comprise GPS sensors, accelerometers, gyroscopes, magnetometers, temperature sensors, strain sensors, and so forth, embodied in microelectromechanical systems (MEMS); or otherwise, and all as adapted in accord with the teachings hereof.

Referring to Figure 2A, the sensing devices 40 of the illustrated embodiment comprise linear accelerometer sensor 40a and rotational sensors 40b-40d for measuring, respectively, acceleration along the longest axis X of the skateboard 20 (elliptical displacement about axis X), pitch (angular displacement about axis Y) and yaw (angular displacement about axis Z). As noted above, other embodiments may use other sensors, e.g., GPS sensors, magnetometers, temperature sensors, strain sensors, instead or in addition.

Illustrated sensing devices 40 may form part of an inertial measurement unit or otherwise, and they may be fabricated embodied in microelectromechanical systems (MEMS) or otherwise. In one embodiment, the rotational sensors 40b-40d are embodied in an STMicromechanics L3C4000P three-axis angular rate sensor, while sensor 40a is embodied in an Analog Devices ADXL345 three-axis accelerometer. These, however, are design choices, from which others skilled in the art may vary in accord with the teachings hereof.

Packaged with the sensors 40a-40d of the illustrated embodiment are microprocessor 44, battery 46, and wireless communication module 48. Together with an appropriate substrate and support-

Track

housing sensing devices 40 therein.

Multiple Sensing Devices

In some embodiments, more than one array of sensing devices 40 are be coupled to the skateboard to allow for additional data to be generated regarding the characteristic(s) of interest. For example, a skateboard 20 can have sensing devices, e.g., in spacers 24 that reside above the trucks of both the front and back wheels. In fact, in some embodiments, one or more of those sensing devices 40 is disposed on the under-portion of the skateboard, e.g., on a shoe, foot, sock, pant leg, belt, backpack, and so forth, in order to provide further data for identifying tracks performed on a skateboard and/or for otherwise generating, transmitting, and analyzing data pertaining to motion of the skateboard.

Digital Data Processor 60

The sensing devices 40 communicate collected measurements to one or more digital data processors—here, depicted as digital data processor 60—for analysis, logging, display and/or transmission to other devices.

The data processor(s) can comprise a dedicated device, such as a dedicated microprocessor (or “controller”) that is embodied with the sensing devices 40, e.g., on the skateboard 20, and/or that is housed separately from the sensing devices 40 (it coupled for communications via Bluetooth, WiFi, cellular, infrared or other wireless or wired transmission medium, or otherwise. An example of the former is microprocessor 44 of Figure 2. An example of the latter is the digital data processor 60 shown in Figure 1 and discussed, e.g., in the section below entitled “Digital Data Processor.”

Alternatively, or in addition, the data processor(s) 60 can be part a multifunction device, e.g., as in the case of a data processor that is embodied in a cell phone, personal digital assistant, or other mobile device (collectively, “mobile device”) and that is in communications coupling (again,

Trick

checked) via application of power to a USB port on unit 42, access to which may be gained via the base 34a or over 34c of the river 24. (That access may be covered, e.g., by a removable plug or otherwise to prevent contamination). In other embodiments, recharging may be provided for via a standard power adapter port, via inductive charging or otherwise.

Communication module 46 enables the transfer of software

Communication module 46 enables the transfer of software (e.g., for purposes of reprogramming the unit 42), control parameter and/or data between the unit 42 (and, particularly, for example, the sensors 44a-44d and/or microprocessor 44) and external devices, e.g., digital data processor 60. The module 46 can support wired transfers, e.g., via the aforementioned USB port or otherwise. In preferred embodiments, it supports wireless transmissions, instead or in addition. This can include Bluetooth, WiFi, cellular, infrared or other wireless protocols.

Module 46 can be constructed and operated in the conventional manner known in the art suitable for supporting the aforesaid and other wired and wireless protocols—as adapted in accord with the teachings hereof.

Software of the type suitable for execution by microprocessor 44 to effect operation of module 46 of the illustrated embodiment is provided below. It will be appreciated that this represents but one technique for configuring the microprocessor 44 to support such operation and that other techniques to configuring the microprocessor are within the scope of the invention.

```

1 2015 module 46
2
3  * Communicator with 100 through Ethernet network, logs data to files.
4  * Processes communications, non-identified receiver devices, issues of a on 100
5  * sends data
6
7  * has very basic error detection and alignment and exclusive buffering
8
9  Import Bluetooth
10 Export USB
11 Export Ethernet
12 Export memory 46 to
13
14 def get over selection of get address():
15     return "Data 46 for Bluetooth devices..."

```

Trick

ing circuitry, these components form a printed circuit board (PCB) 42 that, in the illustrated embodiment, has a form factor of the type as shown in Figure 23—a more complete understanding of which PCB may be attained by reference to the schematic of Appendix I hereto. Of course, other embodiments may package these components in other ways—e.g., on PCBs of other configurations, on chips, in separate PCBs, and otherwise.

While not shown in the illustrated embodiment, the sensing devices can additionally include a pressure sensor (based on piezo-electric or otherwise). This can be housed on PCB 42, though, more typically, it is mounted directly to dock 23 in order to detect when there is a user on the skateboard 20, when the user is landing on the board (e.g., after a jump), when the user and board are both in free-flight and/or when the user falls off the board. Output from the pressure sensor can be used in connection with trick determination, e.g., along the lines discussed below and/or it can be reported (directly or by way of microprocessor 44) to digital data processor 60 as another “measured characteristic” of the board 20.

The device 42 also include an audio output (not shown) that generates an audio signal (e.g., a song and/or sound or series of sounds), e.g., in the manner of the audio output discussed below in connection with digital data processor 60 or otherwise.

Battery

Battery (or other power source) 48 provides power for operation of unit 42 and/or the constituent elements thereof. This is a conventional battery (or other power source) of the type known in the art for household or light industrial use, though other batteries and/or power sources may be used as well or in addition—all as adapted in accord with the teachings hereof. Suitable batteries include, for example, alkaline, nickel-metal hydride, nickel-cadmium, lithium, carbon zinc, and so forth. Preferably, battery 48 is rechargeable and/or removable (e.g., via opening of river cover 24c).

In the illustrated embodiment, battery 48 may be recharged (and its charge, for example,

Trick

fore it is sent to digital data processor 60. It can also detect fault in operation of the unit 42, module 46 and/or sensors 40a-40d, forcing notification to digital data processor 60 and/or to an operational (LUT) and/or display panel (not shown) and/or audio output of unit 42 in case of such detection.

In some embodiments, processing of data generated by sensors 40a-40d is the province of separate digital data processor 60. However, in the illustrated embodiment, microprocessor 44 performs one or more of those tasks and particularly, by way of non-limiting example, the processing of data generated by those sensors to identify tricks (or other faults) performed on the skateboard 20 (or other object).

The illustrated microprocessor 44 also performs control associated with such trick (fault) identification. This includes, by way of example, powering-up or waking the sensors 40a-40d in response to user activation—e.g., double-tapping of the skateboard 20 by the user. This also includes, by way of example, detecting trick (or fault) start, e.g., based on jerk detection or other characteristic changes in forces or motions measured by the sensors. And, it includes by way of example, uploading the identity of detected tricks to the digital data processor 60, e.g., along with underlying or other sensor readings.

In this latter regard, for example, the microprocessor 44 can effect uploading of the identity of an identified trick to the digital data processor 60, along with position information from a GPS sensor (not shown), introduce information from an onboard clock (not shown), maintain velocity and acceleration readings sensor 42a, and so forth—all by way of example. By way of further example, microprocessor 44 can effect uploading of a log of collected sensor readings, if it is unable to identify therefrom a particular trick—or, in some embodiments, even if it is able to identify a trick. An advantage of such logging is, for example, that it makes possible validating what tricks and other actions an operator indeed performed on the skateboard (or other object).

Instead of, or in addition to, uploading trick identity and/or underlying or other sensor readings, the microprocessor can effect notification when pre-selected trick(s) or fence—such as, in the

Trick

```
if (its_fallapath != 0)
    fallapath = 0;
return speed_tapsafe, 0;
```

Microprocessor

Illustrated microprocessor 44 controls and/or configures the unit 42 and/or the constituent elements thereof. The microprocessor 44 can perform any number of functions, as will appreciated by a person skilled in the art, depending on the particular application for which the sensing devices 40 are used. By way of non-limiting example, the microprocessor 44 can power-up, power-down, “sleep,” reset, put-to-sleep, and/or set operational parameters (including, level settings) for unit 42, module 46 and/or sensors 40a-40d. By way of further example, microprocessor 44 can effect software control parameter and/or data transfer between digital data processor 60 and unit 42, module 46 and/or sensors 40a-40d.

Thus, for example, in order to extend the life of the battery 48, the microprocessor 44 can configure sensing devices 40 and/or communications module 46 to enter sleep mode during non-use or inactivity, e.g., if the communications module 46 is unable to connect to the digital data processor 60 for a pre-determined time (e.g., five minutes), in response to a command from the processor 60, in response to a user deactivation command (e.g., a triple-tap on the skateboard 20). And, by way of further example, the microprocessor 44 can configure the communications module 46 to operate in lower power mode when practical. To further extend battery 48 life, the microprocessor 44 preferably activates the sensing devices 40 independently of the communication module.

As will be appreciated by those skilled in the art, various ones of the control and/or configuration operations attributed to the microprocessor 44 may be handled via other functionality in the module 42. Thus, for example, one or more parameters may be learned into read-only memory modules (not shown) provided with the unit 42, may be “hardwired” into circuitry of the PCB, or otherwise, all consistent with the teachings herein.

By way of further example, microprocessor 44 can perform data conditioning (e.g., normalization), data reduction, data compression and other preprocessing of data from sensors 40a-40d to

Trick

Once a start point and end point have been identified, a third step in identifying a data window is to check that a "reasonable" amount of time has passed from the start point to the endpoint. Again, microprocessor 44 sets a threshold on the difference of the time stamp on a potential end point and the time stamp on a potential start point. If this difference is greater than the time threshold, then microprocessor 44 proceeds to compare the data in the identified data window to the signature of what is expected for each trick.

In the illustrated embodiment, there are n unique features of gyroscope and accelerometer data used to identify tricks, and each trick is assigned a collection of n values. Each couple assigned to a particular trick is considered a signature of that trick. If one of the signatures of a trick appears in a data window, that trick is registered as detected.

Referring back to Figure 1, in the illustrated embodiment, the aforementioned features are:

- 1) roll (denoted "R", in the drawing) - total angular displacement about the longest principle axis X of the skateboard given relative positioning of the sensors in the skateboard;
- 2) pitch P - total angular displacement about the second principle axis Y of the skateboard parallel to the ground when the skateboard is at rest on its wheels;
- 3) yaw ("W", in the drawing) - total angular displacement about the principle axis Z of the skateboard perpendicular to the ground when the skateboard is at rest on its wheels;
- 4) acceleration - acceleration detected using the longest axis X of the skateboard;
- 5) initial pitch - the sign of the pitch P detected nearest the start point of the data window. In the drawing, this sign is indicated by "+" and "-" signs adjacent ends of the curved arrow denoting the pitch P.

Each of these features, or "parameters," is bounded by thresholds and lies between three and six

Trick

times of skateboard 20, or "tilt"—score identified. Such notification can be transmitted to the digital data processor 60. Alternatively or in addition, such notification can be effected via an alert to the aforementioned operational LED and/or display panel (not shown) of unit 42, to the aforementioned audio output, or otherwise. Indeed, such a notification can be transmitted or otherwise effected when the processor detects an attempted, but failed, trick.

Trick Detection

As noted above, in the illustrated embodiment microprocessor 44 processes all data generated by those sensors 40 to identify tricks (or other facts) performed on the skateboard 20 (or other objects). An appreciation of this may be gained by reference to the discussion that follows, as well as that provided elsewhere herein. Though attributed to microprocessor 44, it will appreciate that trick (fact) detection can be performed by digital data processor 60 or other functionality, all in accord with the teachings herein.

In the illustrated embodiment, the microprocessor 44 begins trick identification with processing data from the gyroscopes 40b-40d and accelerometers 40a to determine what segment, or "data window", of a data stream to compare against what an expected trick signature (i.e., what a trick is expected to look like in terms of sensor data).

In order to locate such data windows, the illustrated microprocessor 44 first sets a threshold for angular displacement. If the magnitude of angular displacement sensed by the gyroscopes is beyond this threshold about any axis, microprocessor 44 considers this a potential start point of a data window in which to identify tricks.

To determine a potential end point of a data window, the microprocessor 44 sets a separate threshold on the rate of change of angular displacement. This relies on the assumption that when a trick is landed the skateboard 20 suddenly stops rotating (e.g., when it is "caught" by the user). This causes sharp fluctuations in angular displacement data.

Trick

Again, for tricks that rotate about a non-principle axis, yaw exhibits non-obvious behavior and captured by parameter (4).

For tricks that rotate about a non-principle axis, as mentioned above, rotation about the longest principle axis happens the fastest. Since the gyroscopes are fixed to the skateboard, this means that during the course of a trick, the angular velocity registered by the sensors about, say, the principle axis corresponding to yaw will exhibit sinusoidal behavior, likewise for pitch. This makes physical sense, yet confounds the intuition of the typical skateboarder. For example, conventionally a varial flip is described as 360 degrees of roll (a kickflip) combined with 180 degrees of yaw (a dash). However, gyroscope data taken during the course of a varial flip results in roughly 160 degrees of roll and two out of phase sinusoids for pitch and yaw. Difficultly arises when one tries to distinguish tricks which conventionally differ by a 180 degree rotation in yaw, for example the varial flip and the 360 flip (360 degrees in roll and 360 degrees in yaw). The “shape” of the gyroscope data is roughly the same, and differs mostly in the amplitudes of the sinusoids. These amplitudes do not readily yield to the same methods of setting thresholds using in parameter (1) - (3). Instead, how the microprocessor 44 exploits the asymmetric position of the sensors on the skateboard to detect verting/flipped accelerations.

Parameter (4) reflects the accelerometer data from the longest axis of the skateboard. The accelerometer experiences a centrifugal acceleration that is proportional to the square of the angular velocity registered in pitch and yaw by the gyroscopes, as exemplified by the relations below:

$$v = r\omega$$

$$a = v^2/r$$

$$a = r^2 \cdot \omega^2 / r$$

In this way, the difference tricks intuitively described as being a 180 degree rotation in yaw dif-

Trick

fers. Referring to Figure 3, the gray areas indicate the thresholds within which a given trick starting about the longest principle axis (floating roll) would be recognized.

Each of these parameters assumes a value specifying what range, given threshold, certain aspects of gyroscope and accelerometer data fall in. Each combination of values for each parameter unambiguously specifies a type of motion a skateboard has undergone during a data window, whether it be a trick or not.

Parameter (1) reflects how much roll, if any, the skateboard rotates through during the data window. Practically, this is measuring how much kickflip or heelflip has happened during a trick. Notice that any trick that does not rotate primarily about a principle axis necessarily has some non-zero roll. Also, the skateboard rotates most easily about its longest principle axis, since the skateboard has the smallest moment of inertia in this dimension. For these reasons, parameter (1), unlike parameters (2) and (3), is useful for identifying and differentiating tricks that rotate about a single principle axis (namely the longest axis of the skateboard) and tricks that combine rotations about more than one principle axis, such as a varial flip or a 360 flip. The angular velocity is roll is roughly constant for the bulk of a given data window, and the thresholds on parameter (1) determine practically how many kickflip or heelflip rotations have occurred during the course of trick.

Parameter (2) is similar to (1), but reflects the amount of pitch the skateboard rotates through during the data window. Parameter (2) differs from (1) in that it is only useful in determining if rotation about a single principle axis is enough for a trick to have been completed. Practically, this amounts to determining whether a data window contains data for an impossible or a float-foot impossible. Tricks that rotate about a non-principle axis do make gyroscopes register pitch, but in a non-obvious way. This behavior is addressed by parameter (4).

Parameter (3) is entirely similar to parameter (2), save that the information it encodes is the angular displacement about the third principle axis, or yaw. Practically this amounts to determining whether a data window contains data for a dash, frontside or backside, and how much.

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Software of the type suitable for execution by microprocessor 44 in test operation of a mobile 42 is contemplated. Software of this type is not shown, but will be appreciated that this is contemplated to be connected to the mainframe 40 as provided below. It will be appreciated that this represents but one technique for configuring the microprocessor 44 to support such testing as within the scope of the invention.

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Journal of Management Inquiry

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Trick

measured by the sensing devices 40 with information identifying the skateboard 20, its user, the time/place of trick performance and/or characteristic measurement, and/or multi-media content (e.g., images, video, or audio clip) associated with any of the foregoing or otherwise;

- generate displays, visual notifications and/or audio notifications regarding identified tricks, measured characteristics, and/or associated information on an LED and/or display panel (on skates) and/or audio output of association with the data processor 60 and/or the skateboard 20 and/or
- exchange information regarding identified tricks, measured characteristics, and/or associated information with central servers, central stores, other nodes, the Internet and/or otherwise.

By way of non-limiting example, in one embodiment, the digital data processor 60 can support recent trick identification (if any) performed by the microprocessor by analyzing other aspects of skateboard use, e.g., maximum height attained during a skateboard session, longest time in the air during the session, fastest speed attained, longest sustained run, and so forth. It can perform one or more of the aforementioned functions with the results of these analyses, as well or instead. Of course, in some embodiments these analyses can be performed by the microprocessor 44 instead or in addition.

In some embodiments, a given data processor 60 (e.g., a cell phone, PDA or computer) may be capable of operation with multiple different skateboards (or other objects) 20, concurrently or one-at-a-time. This can facilitate, for example, the use of a cell phone 60 with multiple objects (e.g., skateboards, surf boards, etc.) equipped to record with the teachings and owned by the given user or, conversely, by multiple such objects owned by different persons (e.g., friends, companies, etc.).

Trick

trick in the table of Figure 4, that can be reflected in the table, as well, and the microprocessor 44 can take it into account when performing trick identification and/or discrimination.

Digital Data Processor

Referring back to Figure 1, data processor 60 can comprise a dedicated device (e.g., a desktop or laptop computer) or it can be part a multifunction device, e.g., as in the case of a data processor that is embedded in a cell phone, personal digital assistant, or other mobile device (collectively, "mobile device"). In the illustrated embodiment, processor 60 is a communications coupling with the unit 42 and, more particularly, for example, microprocessor 44 and/or sensing devices 40, e.g., via Bluetooth, Wi-Fi, cellular, infrared, or other wireless or wired transmission medium.

In various embodiments, the data processor 60 processes data regarding skateboard 20 and, more particularly, data from with sensors 40a-40d and/or the microprocessor 44 and, optionally, in some embodiments with other "nodes" (as discussed below) to perform one or more of the following functions. Such processing can be performed on the digital data processor 60 using conventional software and data analysis techniques as adapted in accord with the teachings herein:

- process information received from unit 42, and with more particularly, for example, microprocessor 44 and/or sensing devices 40 to quantitatively or qualitatively characterize the motion, location and/or other characteristics of the skateboard;
- identify tricks performed on the skateboard 20 (or other object) (e.g., in embodiments where such identification is not performed by microprocessor 44 and/or in which auxiliary processing by the data processor can facilitate and/or confirm such identification);
- log identified tricks and/or characteristics of the skateboard and/or its environment measured by the sensing devices 40;
- associate identified tricks and/or characteristics of the skateboard and/or its environment

Trick

though, in other embodiments such coupling may be wired, instead or in addition.

In an exemplary embodiment, the digital data processor 60 is a smart phone having a communication module capable of receiving the wireless communication signals generated by the sensing device 40. The smart phone can be held, for example, in a skateboarder's pocket within transmission range of the sensing device 40. Alternatively, the digital data processor 60 can be stationary when the skateboard 20 is not. For example, the digital data processor 60 (whether a smartphone, laptop or otherwise) that is positioned in proximity to a ramp or jump on which tricks and/or other characteristics of the skateboard will be determined. In some embodiments, the sensing device 40 can buffer or store information for transmission to the digital data processor 60 until the two devices are brought within range or otherwise placed in communications coupling (e.g., via wired connection and/or user command).

Associated Information

As noted above, the digital data processor can associate identified tricks and/or characteristics of the skateboard and/or its environment measured by the sensing devices 40 with information identifying the skateboard 20, its user, the time/place of risk, performance and/or characteristic measurement, and/or multimedia content (e.g., images, video, or audio clip) associated with any of the coupling or otherwise.

Thus, for example, a suitably equipped digital data processor 60, e.g., a smartphone, can take GPS readings using its own onboard sensor (or otherwise) and can display or log that along with identified tricks and/or characteristics of the skateboard and/or its environment measured by the sensing devices 40. It can likewise use those GPS readings for visual notifications and/or audio notifications regarding identified tricks and measured characteristics, and/or supply those readings to central servers, control stores, and/or other nodes. Furthermore, it can use those GPS readings in connection with processing information received from unit 42, and still more particularly, for example, microprocessor 44 and/or sensing devices 40.

Trick

Moreover, in some embodiments, the microprocessor 44, unit 42 and/or cell phone (or digital data processor) 60 are equipped in communication to one another and/or to central servers, control stores, and/or other nodes, the Internet, or otherwise via a mesh network, established among themselves or otherwise. This can, for example, facilitate communication among skateboards 20 in the same recreational park, e.g., when only a few of the users have cell phones.

Configuration

Referring back to Figure 1, data processor 60 can comprise a dedicated device (e.g., a desktop or laptop computer) or it can be part of a multifunctional device, e.g., as in the case of a data processor that is embedded in a cell phone, personal digital assistant, or other mobile device (collectively, "mobile device").

It includes one or more modules for the receiving, transmitting, processing, storage, generation and/or display of data of the type conventionally associated with such dedicated and/or multifunctional devices, all as adapted to accord with the teachings herein. For example, the data processor 60 can include a store that is configured and operated utilizing conventional database techniques (as adapted accord with the teachings herein) to record information regarding identified tricks and/or characteristics of the skateboard and/or its environment measured by the sensing devices 40, e.g., for later access by the skateboard user or others.

It can also include an audio output device or module that generates an audio output (e.g., a song and/or a word or series of words), e.g., in response to information received from the skateboard and/or the other nodes (if any) in response to user prompts, or otherwise.

As shown in the drawing, data processor 60 is in communications coupling with the skateboard 20 and, more particularly, unit 40, and still more particularly, for example, microprocessor 44 and/or sensing devices 40, e.g., via Bluetooth, WiFi, cellular, infrared, or other wireless link—

Trick

serves audio nodes.

Audio Output

In one embodiment, the digital data processor 60 includes an audio output module 60a that generates audio output, e.g., a song selected by the user, a pre-recorded sound, a synthesized sound, or otherwise. The module 60a may comprise one or more speakers that are embedded with microprocessors 44, e.g., on the skateboard 20, and/or that are housed separately from it, either embedded for communications via Bluetooth, infrared or other wireless or wired transmission medium. Alternatively, or in addition, module 60a can be part of a mobile device that is in communication coupling (e.g., via Bluetooth, WiFi, cellular, infrared, or other wireless or wired transmission medium, or otherwise) with the digital data processor 60. Regardless, the module 60a may be coupled for audio playback (e.g., as via the headphones illustrated in Figure 1) or otherwise.

Audio output may be activated by the user and its volume, duration or other characteristics controlled by way of a switch (not shown) or otherwise. Alternatively, or in addition, the audio output can be a sound or series of sounds generated in response to data received by the digital data processor 60 from the sensing device 40 regarding a trick or characteristic of the skateboard 20.

For instance, as the skateboard user performs a specific trick or the skateboard exhibits a certain characteristic (e.g., a pre-determined speed, height, etc.), the digital data processor 60 can control the audio output device to generate a sound or series of sounds to alert the user. For example, when unit 42 detects that the user is performing an "ollie," the digital data processor 60 can cause the audio output device to generate a loud cracking noise when the skateboarder takes down on the back edge of the skateboard. By way of another non-limiting example, the digital data processor can cause the audio output device to generate a "whistling" sound when the skateboard 20 is being spun.

In another exemplary embodiment, digital data processor can cause the audio output device to

Trick

The foregoing is likewise true of time and/or date information gathered by the digital data processor 60 at the time it receives trick information and other characteristics from the unit 42, and still more particularly, for example, from microprocessor 44 and/or sensing devices 40. In a preferred embodiment where the digital data processor 60 is, for example, a smartphone carried in the pocket of the skateboard user, the foregoing provides a convenient way to associate location, time and/or date information with the trick's and/or characteristics of the skateboard and/or its environment.

By way of further example, digital data processor 60 can also include a keypad, a camera, or a microphone or other peripherals capable of generating multimedia content (e.g., text, images, video, and/or audio). Indeed, a suitably equipped data processor 60a can download or acquire such content from other devices and/or from the Internet. Regardless, as shown, the digital data processor 60 can display or log this content along with identified tricks and/or characteristics of the skateboard and/or its environment, can use that multimedia content in visual notifications and/or audio notifications regarding identified tricks and measured characteristics; can supply that content to central servers, central stores, and/or other nodes; and/or can use that content in connection with processing information received from unit 42, and still more particularly, for example, from microprocessor 44 and/or sensing devices 40.

In the foregoing ways, the digital data processor 60 can associate multimedia content with identified tricks and/or other characteristics of skateboard and/or its environment. In an embodiment where the digital data processor 60 is, for example, a smartphone carried in the pocket of the skateboard user, the foregoing provides a convenient way to associate pictures of a skateboard ramp, a video of a jump, or a song that was played while performing a trick, etc., with particular tricks by the skateboard user.

In some embodiments, the digital data processor "automatically" associates such content with identified tricks and/or other characteristics—e.g., as where it associates a pre-stored photo of the user and/or his/her skateboard (or other equipment) and/or a pre-selected song with the identified trick and/or other characteristics for display, logging, notification, or supply to other servers.

Trick

The digital data processor 60 can drive the LCD or other display to present multimedia content associated with identified tricks and/or characteristics of the skateboard, for example. This can be, for example, a photograph or video of the particular trick or motion being performed. Alternatively or in addition, it can be a virtual snapshot or video of the skateboard 20 as it performs, for example, a particular motion or trick. As will be appreciated by the skilled artisan, the virtual representation of the kinetic information can be generated by the digital data processor 60 in accordance with known methods and algorithms, adapted in view of the teachings herein.

By way of non-limiting example, processor 60 drives the display to render a virtual display of skateboard 20 in three-dimensions based on the data generated by the sensing device 40. The display interface 62a can be configured such that the virtual display of the skateboard 20 can be repositioned in virtual space (e.g., rotated) by user interaction. Moreover, in some embodiments, the processor 60 drives the display to overlay renderings of two or more iterations of a trick, based on the data generated by the sensing device 40, to make it easy to see variation.

In one embodiment, the user of the primary digital data processor 60 can control the frame rate and virtual camera angle of the virtual display of the skateboard 20 such that the user can view the skateboard 20 as it performed a particular action in use, for example, how the object 20 moved over time. Further, in an open source three-dimensional game engine is an example of suitable software for use in accordance with the teachings herein.

Further, if the physical location at which the action was performed is known, the processor 60 can drive the display to model that location and to overlay on it a display of the skateboard in motion, based on the data generated by the sensing device 40.

Multimedia System

A system 10 of the type shown in Figure 1 and described above can have one "mode" in a larger system that includes, in addition to system 10, one or more other such systems. The respective microprocessors 44 and/or digital data processors 60 of those systems may communicate with

Trick

generate an audio output (e.g., a song with a given rhythm) that is manipulated based on the characteristics of the skateboard 20. By way of non-limiting example, the playback of the song can be sped up or slowed down in response to the speeding up or slowing down, respectively, of the skateboard 20. An increase in height (e.g., a jump), for example, of the skateboard 20 can amplify the high tones of the audio output, while a decrease in height (e.g., a landing) can amplify the low tones. Variations in the audio output can also prompt the user (e.g., skateboarder), for example, to perform a certain task (e.g., speed up) or alert the user to attempt a new action.

In this way, the digital data processor 60 can be used as a learning tool. In reference to a certain action desired to be performed by a skateboarder, for example, the audio output device can generate audio output (e.g., a signal) to alert the user to perform a sequence of actions, or perform the next in a sequence of actions, in order to attain the desired characteristic(s).

In addition to, or in the alternative to, outputting the audio output in real-time, the digital data processor 60 can associate an audio signal with identified tricks and/or characteristics of the skateboard and/or its environment measured by the sensing device 40. If the user (or another subsequently accesses a stored record of that trick or other characteristic, the digital data processor 60 or other device can replay the associated audio signal—e.g., allowing the user or another to relive the occasion.

Graphical Display

In one embodiment, the digital data processor 60 is coupled to an LCD or other display for presentation of information regarding identified tricks, characteristics of the skateboard and/or its environment, and/or associated information of the type discussed above. This can include, for example, display of tables, graphs, scores, virtual images (or a series of images), videos, plots, or other graphic or textual representations of the trick, other characteristic(s) of the skateboard 20 and/or associated information. In some embodiments, the digital data processor can be responsive to user input to manipulate the display, e.g., zoom, pan/scroll, filter, and so forth.

Trick

In view of the foregoing, what we claim is:

1. A system for skateboarding, comprising:
 - A. a skateboard,
 - B. one or more sensors that are coupled to the skateboard to measure one or more characteristics thereof,
 - C. a data processor that is in communications coupling with the one or more sensors and that identifies a trick performed on the skateboard.
2. The system of claim 1, wherein the data processor identifies the trick based, at least in part, on correspondence between characteristics of the motion measured by the one or more sensors and a signature associated with each of one or more tricks.
3. The system of claim 1, in which one or more of the sensors are coupled to a user of the skateboard.
4. The system of claim 1, in which one or more of the sensors is gyroscope and/or other, which measures rotation of the skateboard and/or the user thereof.
5. The system of claim 1, in which one or more of the sensors measure rotation around at least two axes of the skateboard.
6. The system of claim 1, in which one or more of the sensors measure rotation around at least three axes of the skateboard.
7. The system of claim 1, in which one or more of the sensors are any of accelerometers,

Trick

with one another on a peer-to-peer basis. Alternatively, or in addition, these systems may be coupled to a central server for logging of identified tricks, skateboard characteristics and/or associated information generated by the systems 10. Moreover, they may be coupled to a central server that facilitates the exchange of such tricks, characteristics and/or associated information between the nodes, e.g., in support of a social network, to facilitate competitions or otherwise, as discussed by way of example in incorporated-by-reference United States Patent Application Serial No. 61/371,164, filed August 3, 2010, United States Patent Application Serial No. 61/371,164, filed August 5, 2010, and United States Patent Application Serial No. 61/386,207, filed September 24, 2010. Reference is had in this particular regard and by way of non-limiting example, to the system 10 shown in Figures 4 of those respective applications and discussed in the accompanying text.

Conclusion

Described above are methods and systems meeting the objects and goals set forth herein. Those skilled in the art will appreciate that the embodiments shown in the drawings and described in the accompanying text are merely examples of the invention and that other embodiments, incorporating modifications and changes therein and including combinations of foregoing embodiments, fall within the scope of the invention.

Thus, for example, although the figures and corresponding text herein are principally directed to embodiments employing skateboards, the teachings herein may be utilized for identifying other kinds of motion of the user alone or in connection with other objects. An enumeration of example such objects is provided elsewhere herein.

In view of the foregoing, what is claimed is:

- Trick
- measurements received from the sensor.
18. The system of claim 1, comprising two or more digital data processors.
19. The system of claim 18, wherein a first said digital data processor is coupled to the skateboard and wherein a second digital data processor is disposed remotely from the skateboard but is in communications coupling with any of the first said digital data processor and the one or more sensors.
20. The system of claim 19, wherein the first digital data processor performs said trick identification based on measurements made by the one or more sensors.
21. The system of claim 20, wherein the first digital data processor transmits the trick identification to the second digital data processor.
22. The system of claim 21, wherein the first digital data processor transmits the trick identification to the second digital data processor along with measurements from one or more sensors.
23. A method for skateboarding, comprising
- A. measuring one or more characteristics of motion of a skateboard with one or more sensors,
- B. with a data processor that is in communications coupling with the one or more sensors, identifying a trick performed on the skateboard,
- C. where the identifying step includes finding a correspondence between characteristics of the motion measured by the one or more sensors and a signature associated with each of
- Trick
- magnometers, global positioning sensors, and strain sensors.
8. The system of claim 1, in which one or more of the sensors are capable of measuring any of speed, acceleration, jerk, yaw, pitch, and roll of the skateboard and/or the user thereof.
9. The system of claim 1, wherein the data processor is coupled to the skateboard and/or the user thereof.
10. The system of claim 1, wherein the data processor comprises an address (i.e., is retrofitted) to the skateboard.
11. The system of claim 1, wherein the data processor is integral to the skateboard.
12. The system of claim 1, wherein the data processor is any of a clip-on, wearable, pocketable, or carry-along device.
13. The system of claim 1, in which the data processor is disposed remotely from the skateboard.
14. The system of claim 13, in which the data processor comprises part a multifunction device.
15. The system of claim 14, in which the multifunction device is any of a cell phone, personal digital assistant, or other mobile device.
16. The system of claim 15, in which the digital data processor is coupled for wireless communications with one or more of the sensors.
17. The system of claim 16, wherein the digital data processor any of logs and/or displays

Track

one or more tracks.

Track

measurements received from the sensor.

41. The system of claim 34, comprising two or more digital data processors.
42. The system of claim 41, wherein a first said digital data processor is coupled to the object and wherein a second digital data processor is disposed remotely from the object but is in communications coupling with any of the first said digital data processor and the one or more sensors.
43. The system of claim 42, wherein the first digital data processor performs said track identification based on measurements made by the one or more sensors.
44. The system of claim 43, wherein the first digital data processor transmits the track identifications to the second digital data processor.
45. The system of claim 44, wherein the first digital data processor transmits the track identifications to the second digital data processor along with measurements from one or more sensors.
46. A method for tracking, comprising:
 - A. measuring one or more characteristics of motion of an object with one or more sensors,
 - B. with a data processor that is in communication coupling with the one or more sensors, identifying a track performed with the object,
 - C. where the identifying step includes finding a correspondence between characteristics of the motion measured by the one or more sensors and a signature associated with each of

Trick

Appendix I

Trick

Abstract

The invention provides improved devices, systems and methods for sketchboarding (and other *spotting* activities) that involve motion of a sketchboard to identify tricks performed on it by a user. A system according to one aspect of the invention includes (i) a sensing device that is attached (or otherwise coupled) to the sketchboard and that measures a physical characteristic of a, and (ii) a data processor that identifies the foot or trick (or other action) performed by or on the sketchboard based, at least in part, on correspondence between physical characteristics of motion and/or of the environment measured by the sensing device(s) and a unique signature associated with each of one or more possible tricks.

Track

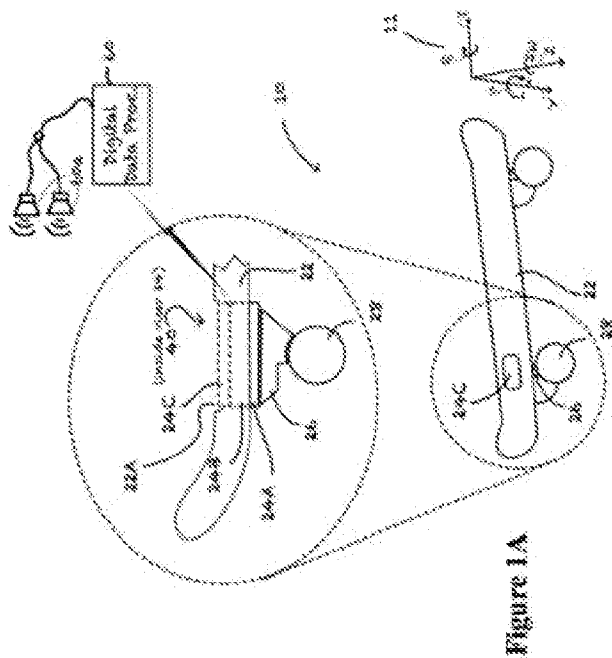
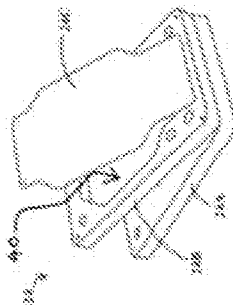
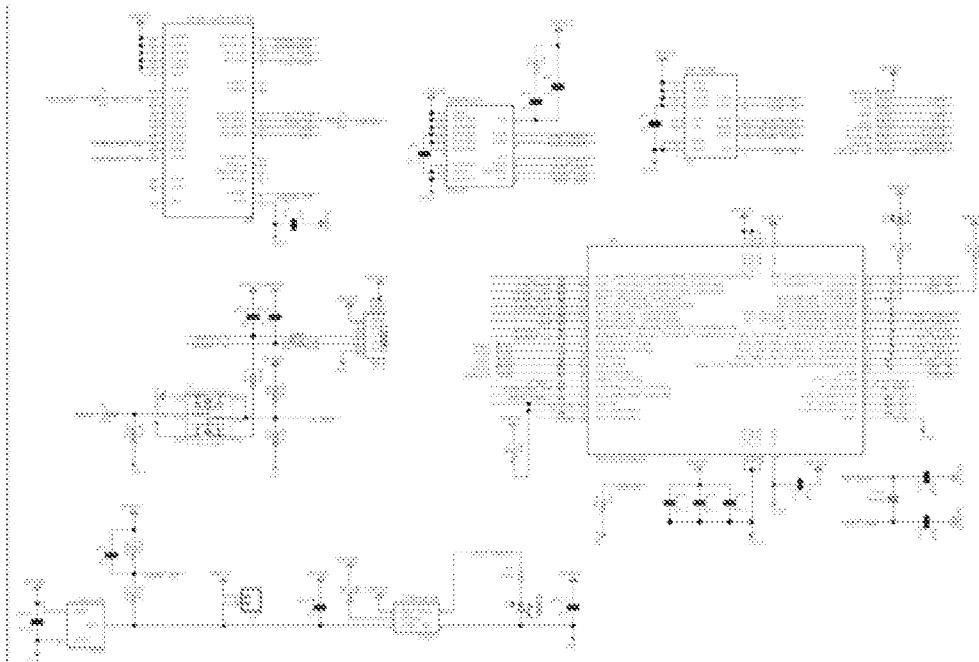


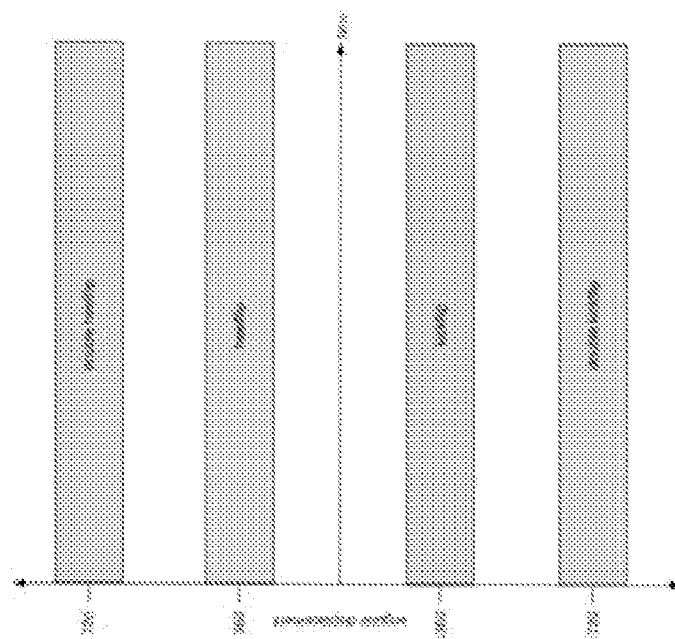
Figure 1B



Track

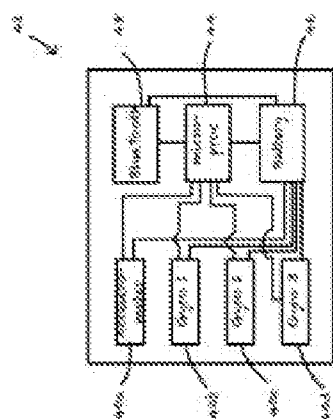


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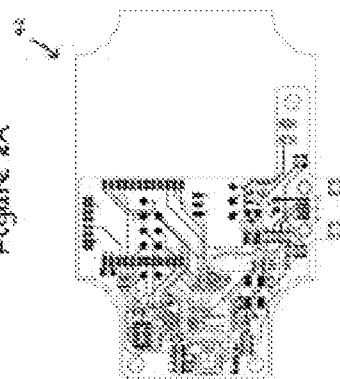


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Track

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Track

$Q(x)$	$Q(x)$	$Q(x)$	Track
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1×10^5	1×10^5	1×10^5	B
1×10^6	1×10^6	1×10^6	C
1×10^7	1×10^7	1×10^7	D
1×10^8	1×10^8	1×10^8	E
1×10^9	1×10^9	1×10^9	F

Figure 4

In view of the foregoing, what is claimed is:

1. A digital data processing system, comprising:
 - a measurement device attached to an object and comprising a sensor for measuring the motion, position, and/or orientation of the object over time;
 - a portable digital data processor communicatively coupled with the first digital data processor via a wireless communications link;
 - the measurement device operable to wirelessly transmit information about the motion, position, and/or orientation of the object over time ("spatial information") to the digital data processor;
 - the portable digital data processor operable to wirelessly receive that spatial information from the measurement device, to display the motion, position, and/or orientation of the object over time, and to compare the motion, position, and/or orientation of the object, over time with that of another object whose spatial information has been obtained via a measurement device attached thereto and transmitted to the portable digital data processor.
2. The system of claim 1, wherein the portable digital data processor comprises a smart phone, personal digital assistant, or handheld device.
3. The system of claim 1, wherein the sensor comprises an accelerometer, gyroscope, or magnetometer.
4. The system of claim 1, wherein the wireless link operates in accord with Bluetooth, wireless Ethernet, etc.
5. The system of claim 1, wherein the object comprises sports equipment.
6. The system of claim 1, wherein the object comprises a skateboard.
7. The system of claim 1, wherein the motion, position, and/or orientation of the object over time is controlled by a user.
8. The system of claim 1, wherein the portable digital data processor comprises an imaging device that photographs and/or films the object.
9. The system of claim 1, wherein any of the measurement device and the portable digital data processor comprises a location sensor that records a location of the object and associates that location with the spatial information.
10. The system of claim 1, wherein the portable digital data processor analyzes the spatial information so as to calculate a rating associated therewith.
11. The system of claim 1, wherein the portable digital data processor analyzes the spatial information to detect the presence of one or more predetermined values for motion, position, and/or orientation.
12. The system of claim 1, wherein the portable digital data processor analyzes the spatial information to detect the presence of a sequence of predetermined values for motion, position, and/or orientation of the object.
13. A digital data processing system, comprising:
 - a measurement device attached to an object and comprising a sensor for measuring a value of at least one physical characteristic of the object over time;
 - a portable digital data processor communicatively coupled with the first digital data processor via a wireless communications link and communicatively coupled with a server digital data processor;
 - the measurement device operable to wirelessly transmit information about the value of the at least one physical characteristic of the object over time ("physical characteristic information") to the digital data processor;
 - the portable digital data processor operable to wirelessly receive the physical characteristic information of the object from the measurement device, to display the physical characteristic information of the object, and to transmit the physical characteristic information of the object to the server digital data processor for storage and/or comparison with physical characteristic information of other objects.
14. The system of claim 13, wherein the physical characteristic comprises any of motion, position, and orientation of the object.
15. The system of claim 13, wherein the server digital processor is operable to collect physical characteristic information from a plurality of portable digital data processors and/or measurement devices associated with other objects.
16. The system of claim 13, wherein the server digital data processor is operable to transmit the physical characteristic information of the object to at least other portable digital data processor.
17. The system of claim 13, wherein the server digital data processor ranks the physical characteristic information of objects according to a scoring system.
18. The system of claim 13, wherein the server digital data processor ranks users based on the physical characteristic information of objects associated therewith.
19. The system of claim 13, wherein the portable digital data processor comprises a smart phone, personal digital assistant, handheld device
20. The system of claim 13, wherein the sensor comprises an accelerometer, gyroscope, magnetometer
21. The system of claim 13, wherein the wireless link operates in accord with Bluetooth, wireless Ethernet, etc.
22. The system of claim 13, wherein the object comprises sports equipment
23. The system of claim 13, wherein the object comprises a skateboard
24. The system of claim 13, wherein the motion, position, and/or orientation of the object over time is controlled by a user.
25. The system of claim 13, wherein the portable digital data processor comprises an imaging device that photographs and/or films the object.
26. The system of claim 13, wherein any of the measurement device and the portable digital data processor comprises a location sensor that records a location of the object and associates that location with the spatial information.
27. The system of claim 13, wherein the portable digital data processor analyzes the spatial information so as to calculate a rating associated therewith.
28. The system of claim 13, wherein the portable digital data processor analyzes the spatial information to detect the presence of one or more predetermined values for motion, position, and/or orientation.
29. The system of claim 13, wherein the portable digital data processor analyzes the spatial information to detect the presence of a sequence of predetermined values for motion, position, and/or orientation of the object.
30. A method comprising:
 - with a sensor attached to an object, sensing any of the motion, position, and/or orientation of the object over time;

wirelessly transmitting information about the motion, position, and/or orientation of the object over time from the sensor to a portable digital data processor;
at least one of displaying and comparing with like data received from another measurement device information about the motion, position, and/or orientation of the object.

31.-38. (canceled)

39. A method comprising:

with a sensor attached to an object, sensing a physical characteristic of the object over time;

wirelessly transmitting information about the physical characteristic that varies over time from the sensor to a portable digital data processor;

collecting with the portable digital data processor any of location, still images and video images in a locale of the object;

sending, from the portable digital data processor to a server digital data processor, information about the physical characteristic that varies over time and, optionally, at least one of said location, still images and video images; from the server digital data processor, causing information about the physical characteristic that varies over time and, optionally, at least one of said location, still images and video images, to be communicated to others.

40.-52. (canceled)

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